AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

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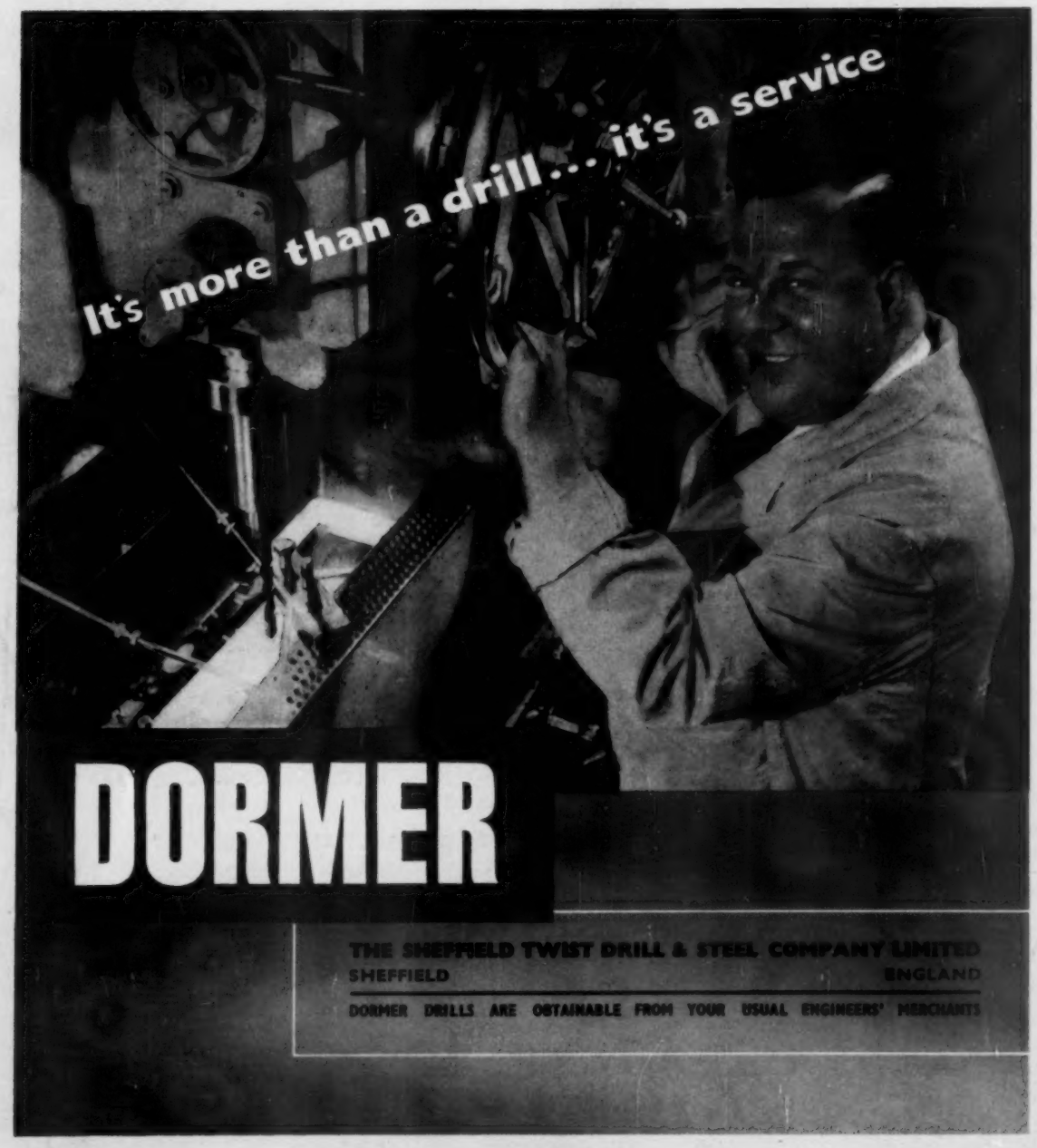
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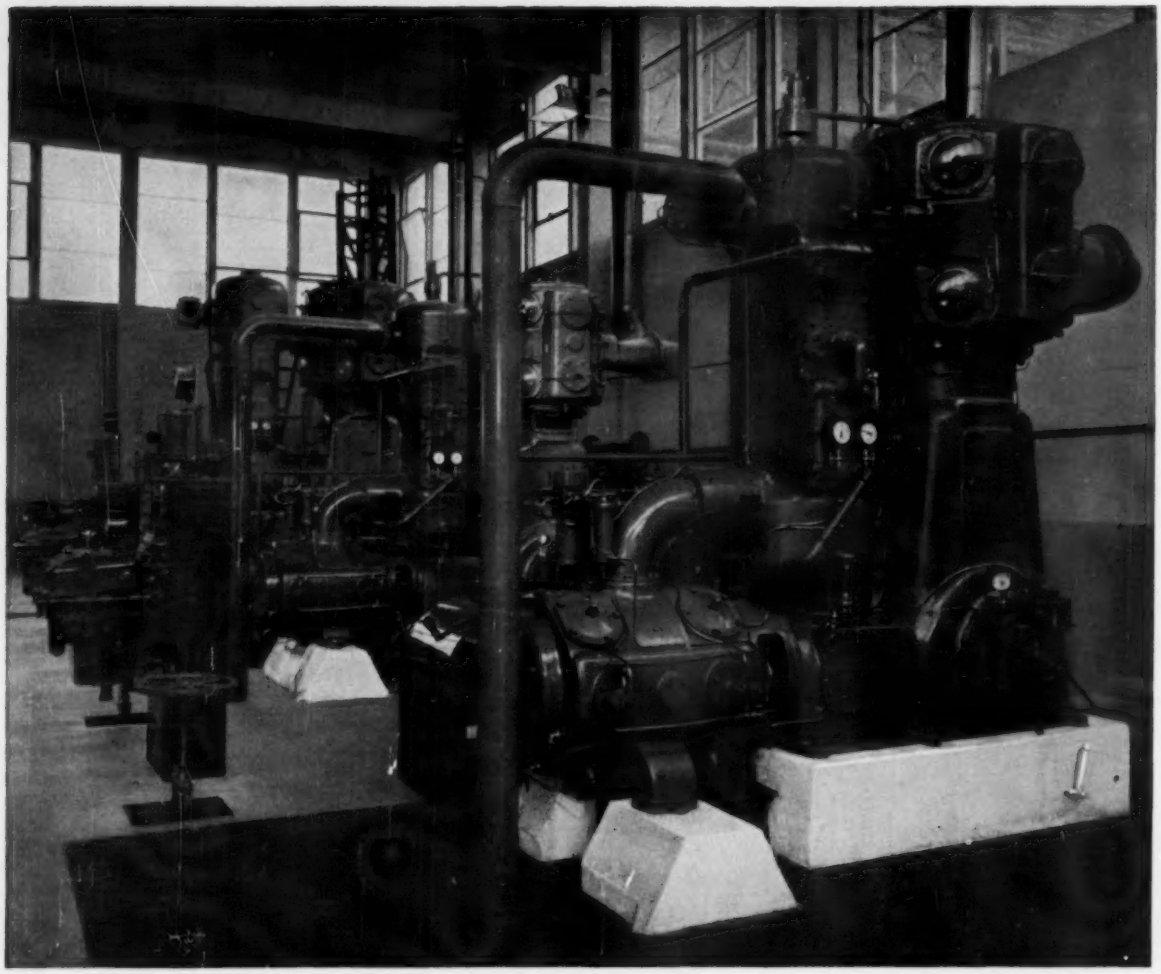

Atlas Copco compressors provide air for British car body firm

When the new 400,000 sq. ft. Swindon plant of Britain's Pressed Steel Company Limited was planned, the compressor installation was naturally of prime importance. Two Atlas Copco AR7 compressors were installed and have been running trouble free, nine hours a day, 5 days a week since January 1956 and an AR9 has recently been installed to meet the steadily increasing demand.

They supply compressed air, first, for the clutch control and balancing of power presses ranging up to 1,000 tons capacity: second, for the spot welding guns and other air tools in the Company's machine shop.

At 100 lbs/sq. in. the free air delivery of the 318 hp AR7 is 1,740 cfm. The output of the 586 hp AR9 is 3,210 cfm. This means that only 18.3 hp is required for every 100 cu. ft. of air delivered per minute at 100 lbs/sq. in., and this extremely high efficiency has impressed industrial planners not only at the Pressed Steel Company but throughout the world.

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The Atlas Copco Group puts compressed air to work for the world. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world. For further details, contact your local Atlas Copco Company or Agent, or write to Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Ltd., Beresford Avenue, Wembley, Middx.

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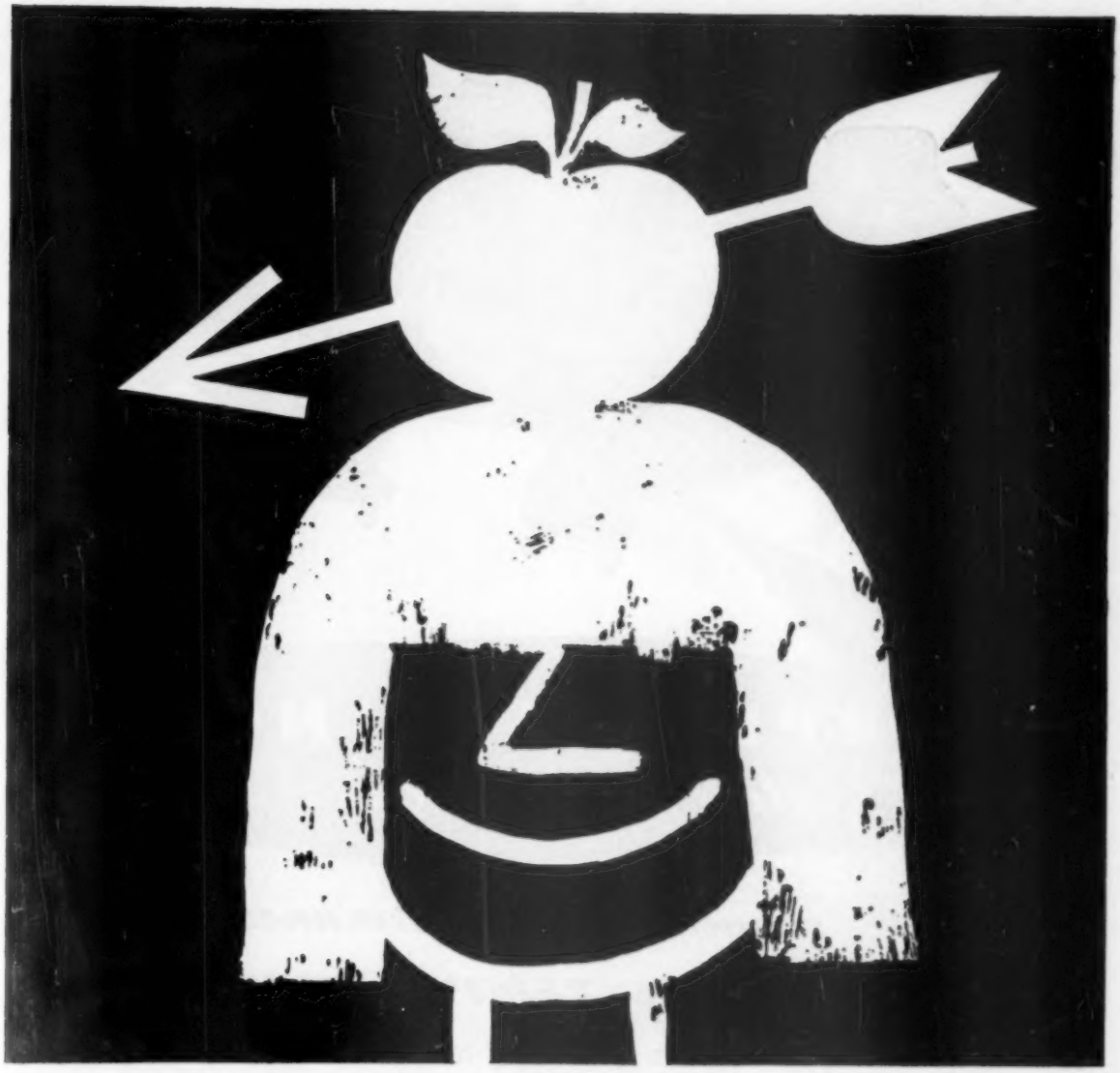

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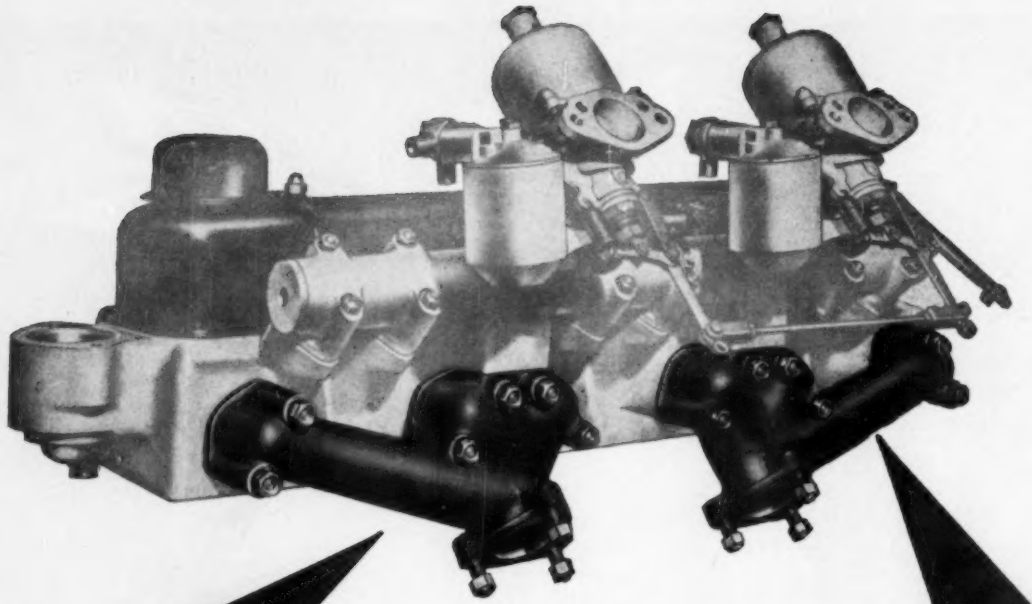

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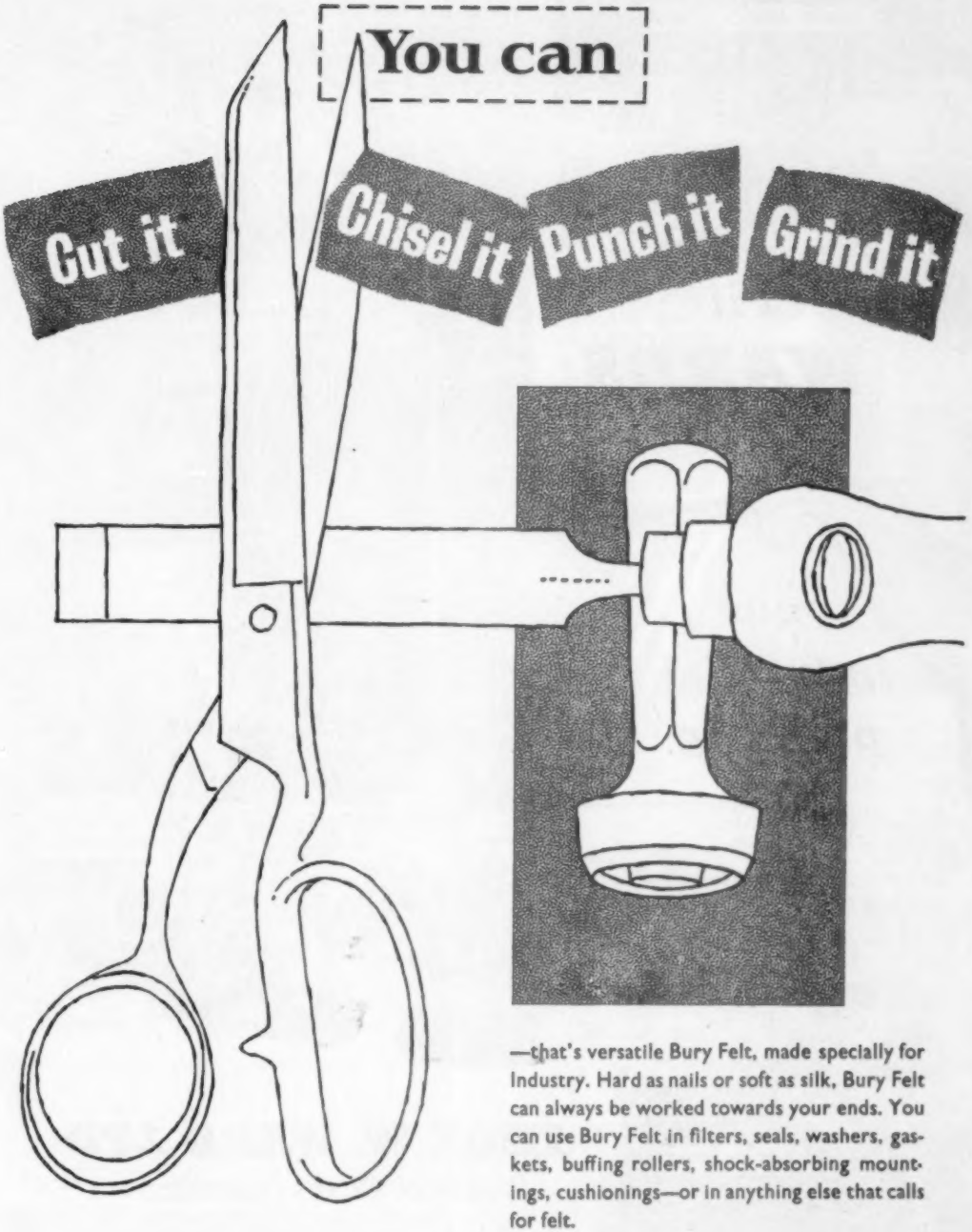

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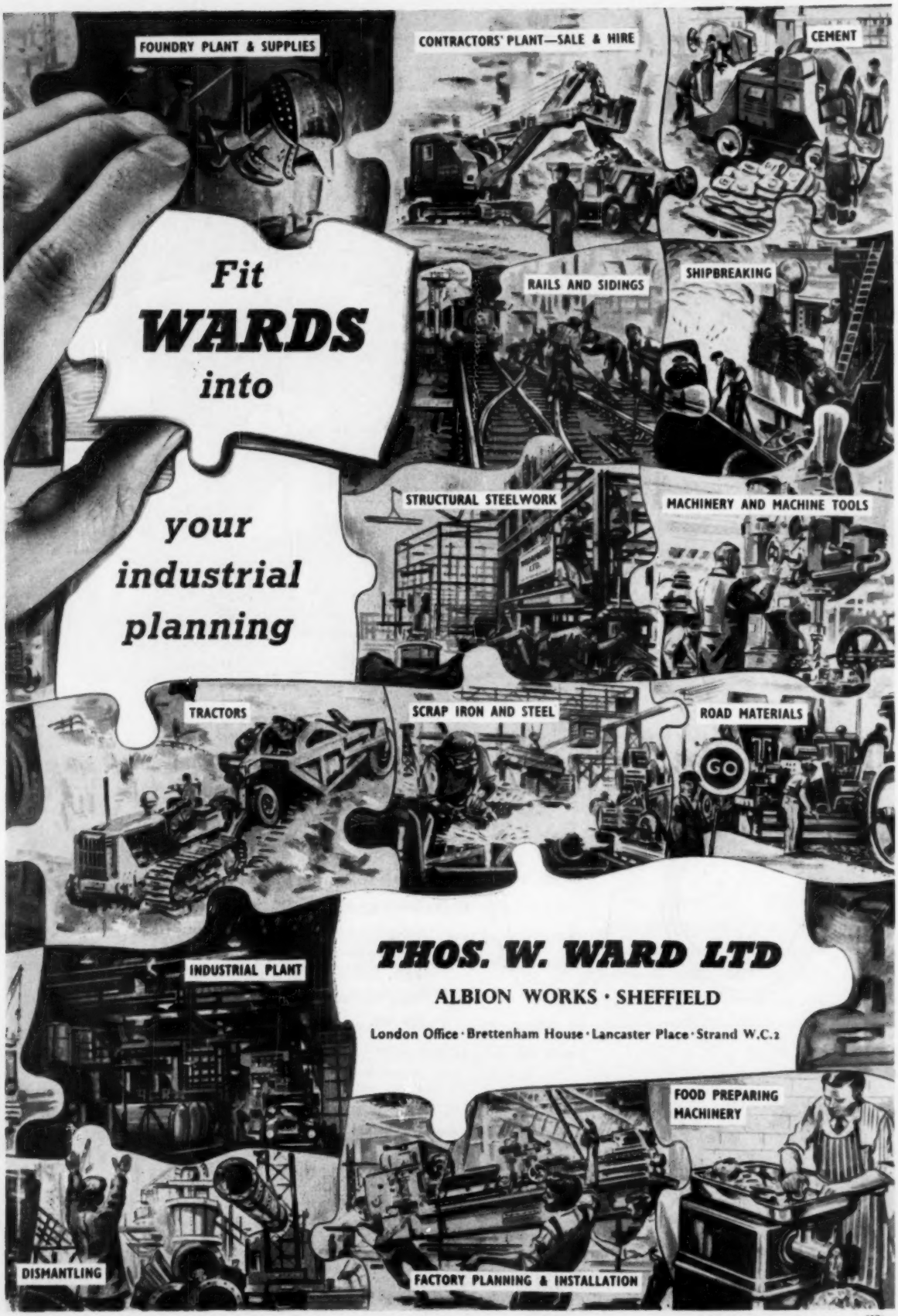
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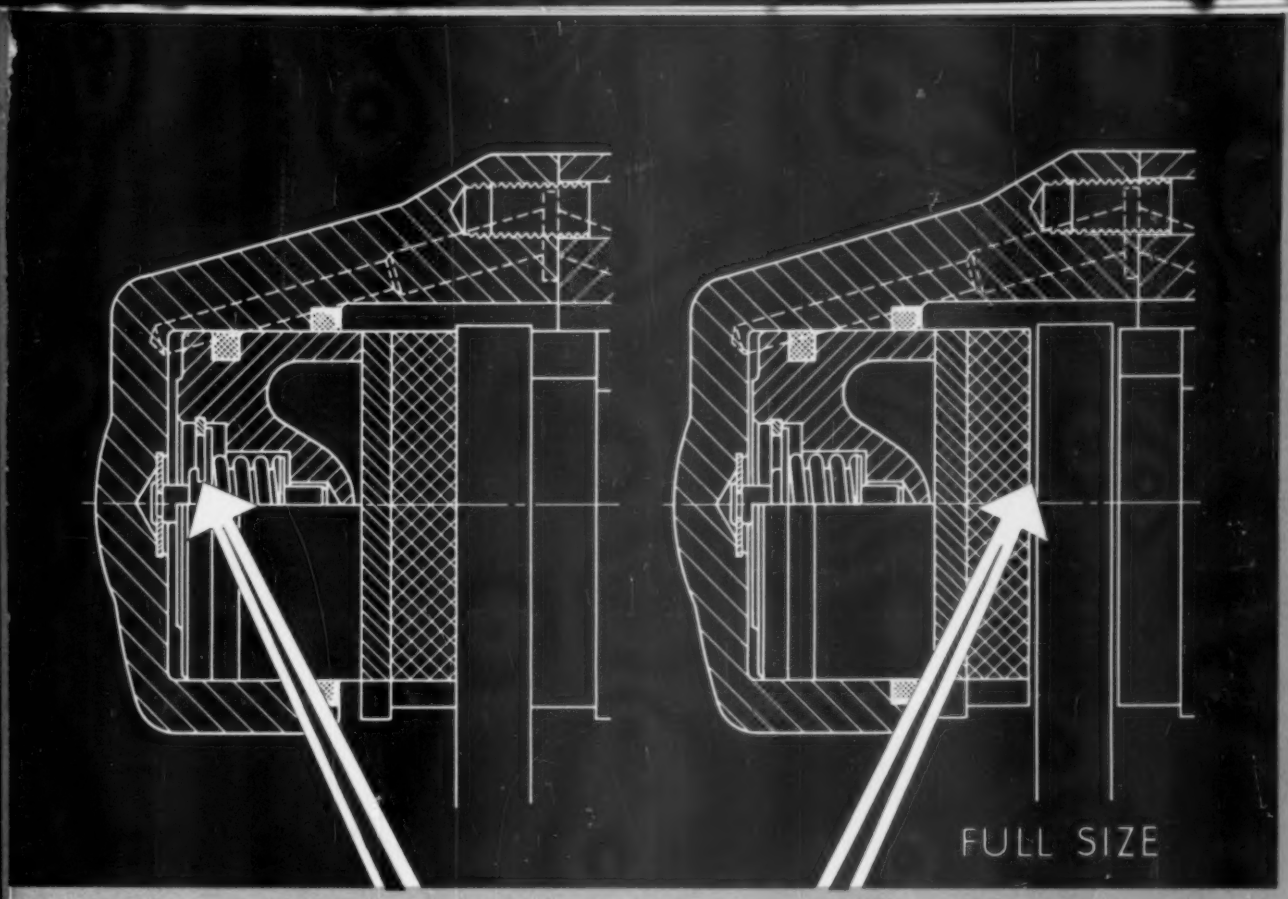

LOCKHEED *hydraulic* DISC BRAKES

The automatic adjusters

The blue-print shows, exaggerated, the action of the self-adjuster: the arrows point (left) to the 'positive clearance' travel in the adjuster ('on' position) and, right, to the same clearance between friction pad and disc in the 'off' position.

Lockheed disc brakes incorporate adjusters of the positive clearance type, operating automatically throughout the life of the friction pad.

The adjusters are built into the pistons, and incorporate pull-off springs so arranged that they operate only over the constant and minute travel between the 'on' and 'off' pad positions. Thus minimum pedal travel is maintained under all conditions.

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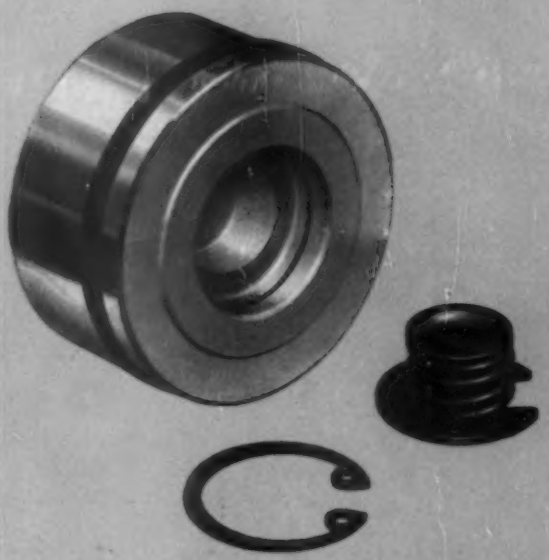

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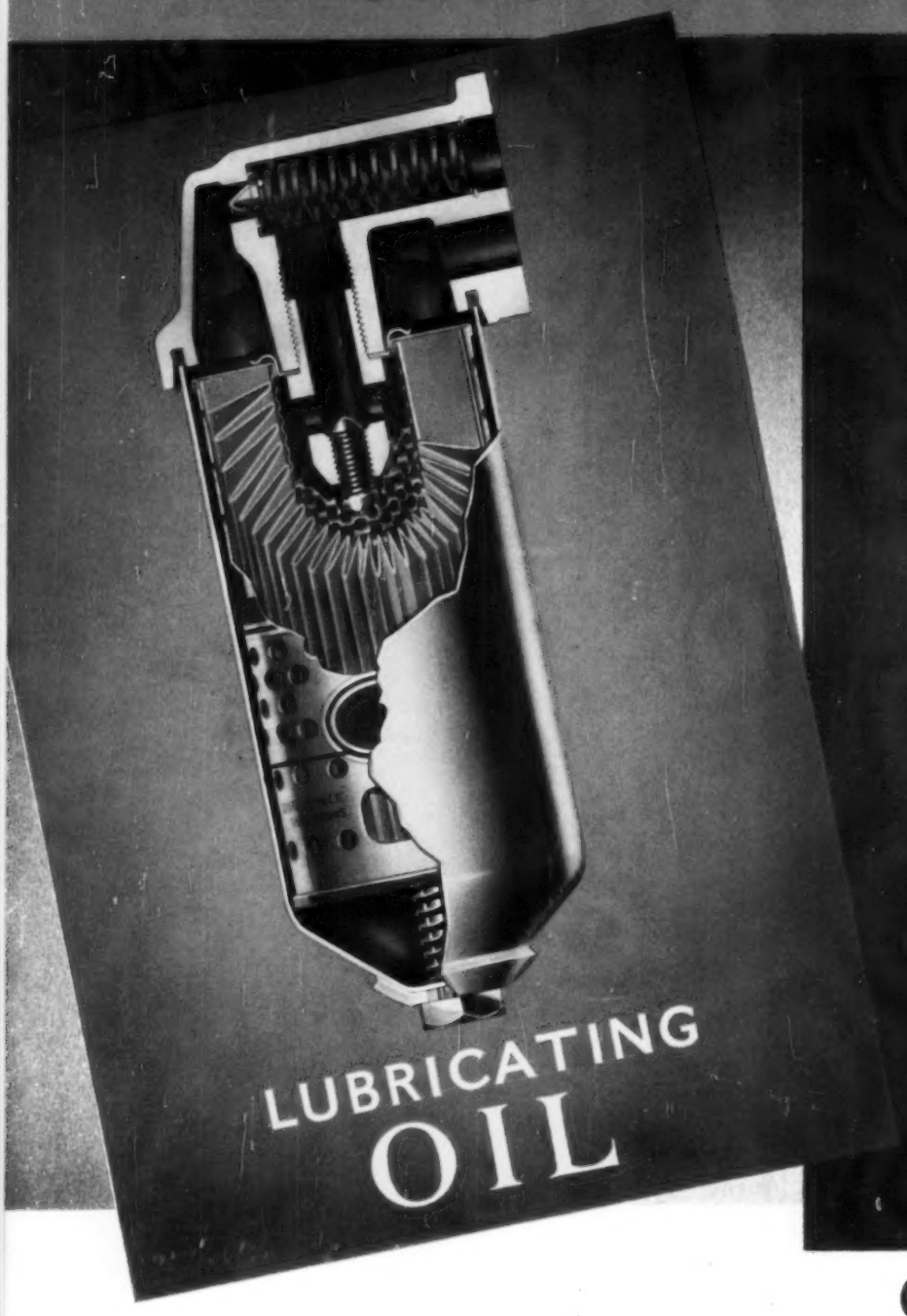

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Purolator filters are in use on commercial vehicles, agricultural tractors, passenger cars, industrial engines and air compressors.

Purolator 'Micronic' filters for lubricating oil, fuel and air are proving successful in every sphere.

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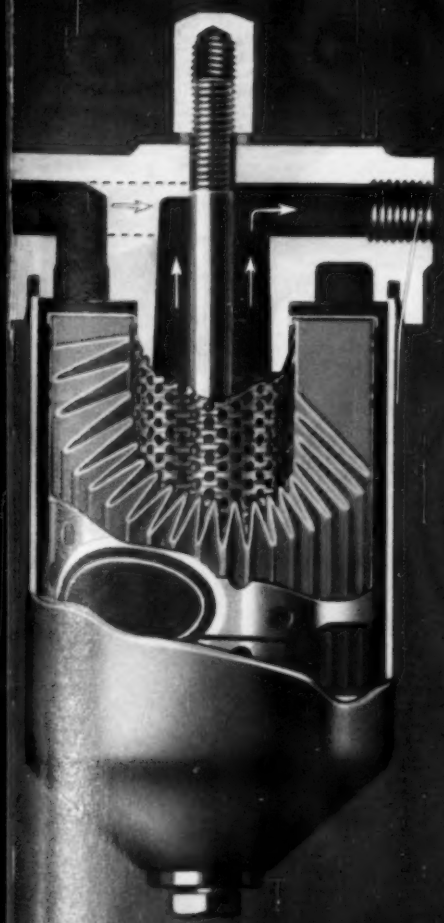

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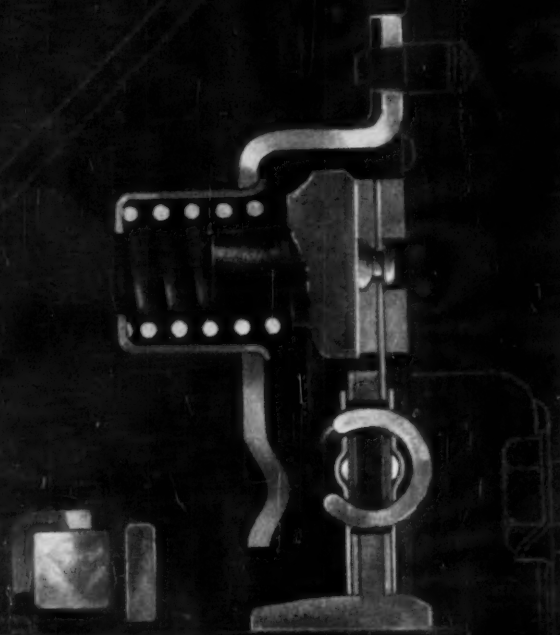

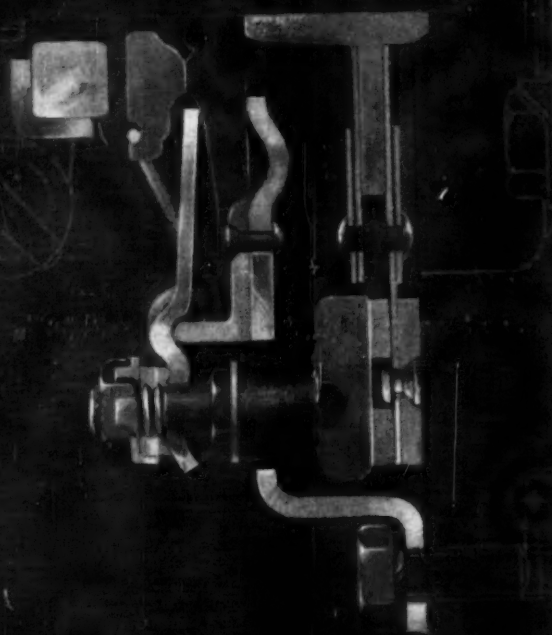

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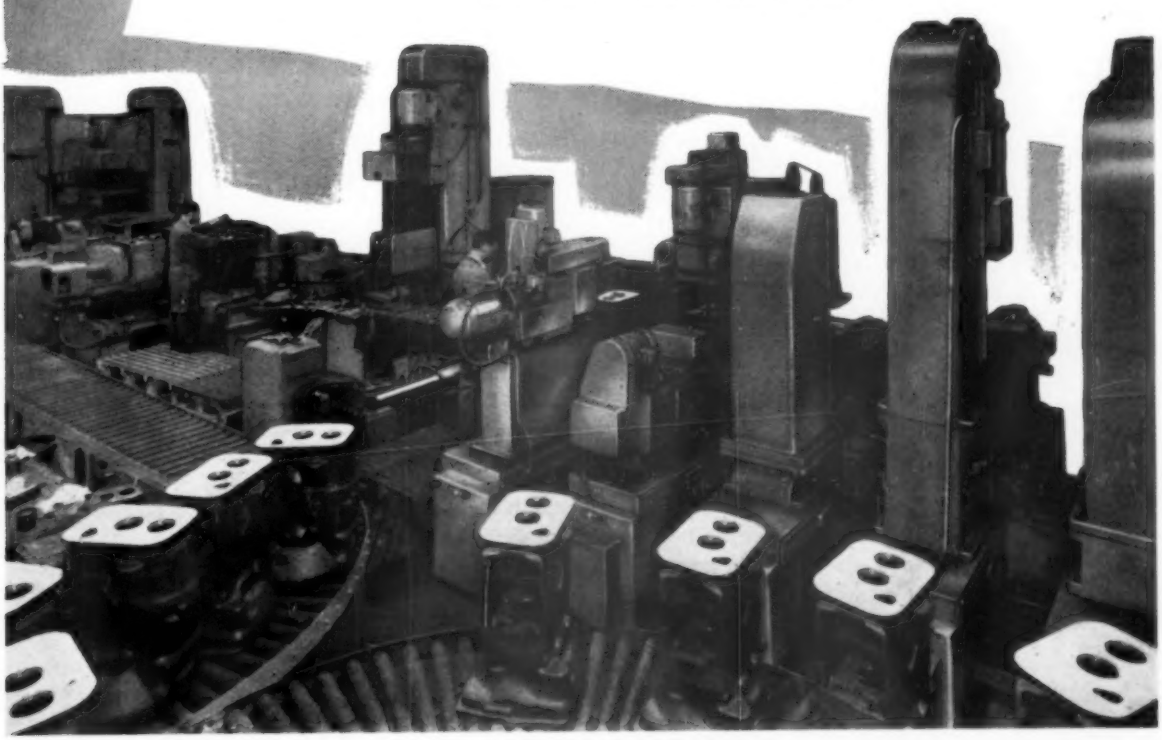

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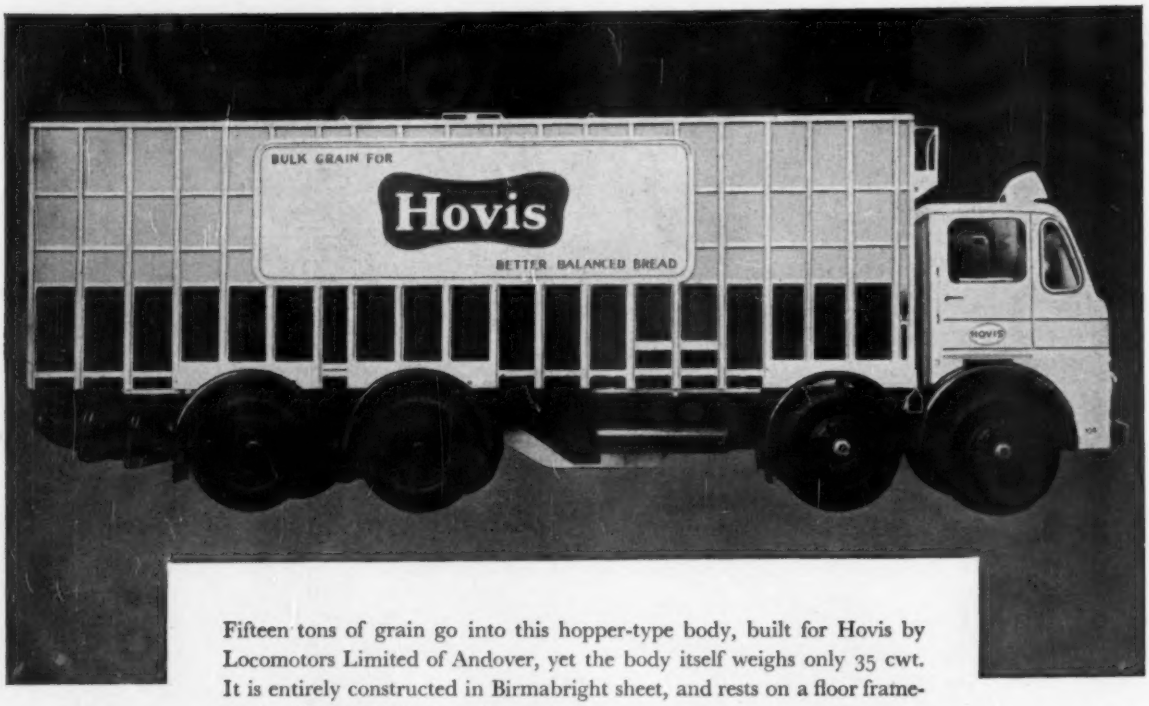
Hovis use BIRMABRIGHT for bulk grain transport



Fifteen tons of grain go into this hopper-type body, built for Hovis by Locomotors Limited of Andover, yet the body itself weighs only 35 cwt. It is entirely constructed in Birmabright sheet, and rests on a floor framework of Birmabright extruded sections.

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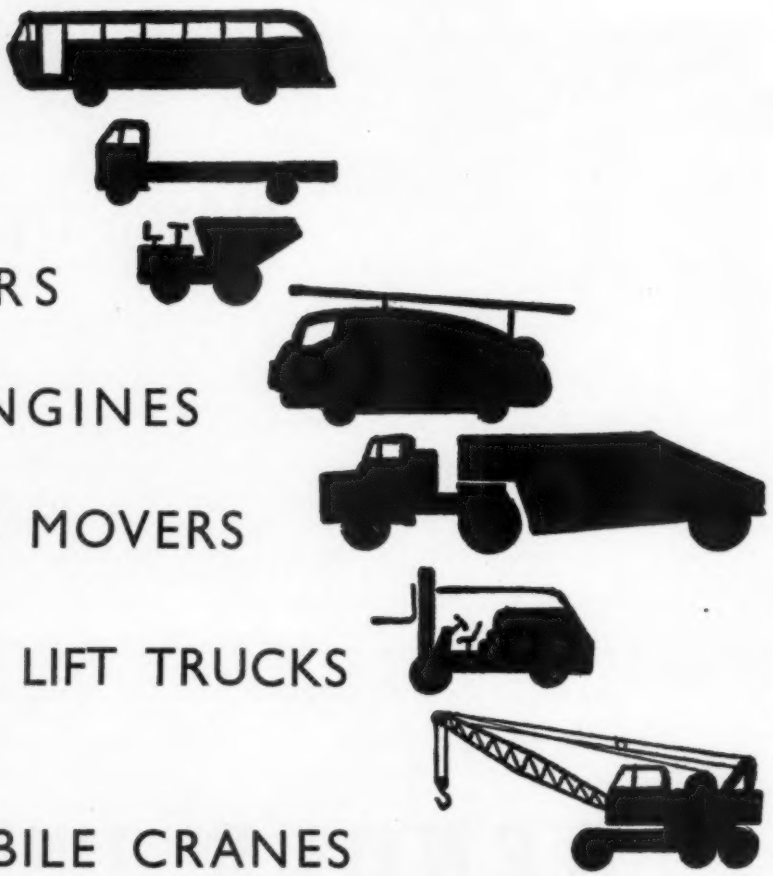

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A suspension incorporating Andre Air Springs and levelling valves assures that the floor of the vehicle is always parallel to the axle, thus uneven loading and severe crown road conditions etc. are overcome, giving a more pleasant and easy ride for the driver. For Passenger Vehicles step heights remain constant irrespective of load.

ALWAYS THE SAME RIDE WHETHER LIGHT OR LADEN VEHICLE

A feature of air springing is that, due to the action of the levelling valves, the position on the load deflection graph remains constant irrespective of load; consequently the frequency remains the same for all conditions of service. This also has the effect of eliminating bouncing due to resonance conditions, thus reducing maintenance not only of the suspension but chassis and body. It also affords greater protection for the goods or passengers being carried.

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This ideal suspension gives greater tyre life.

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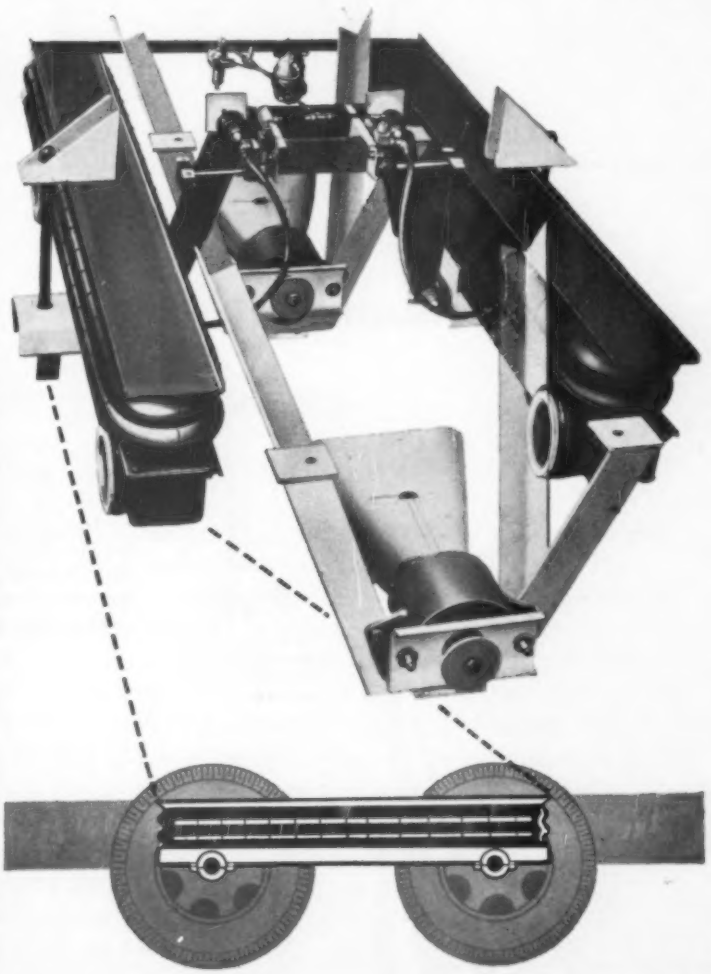

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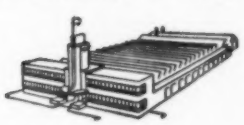

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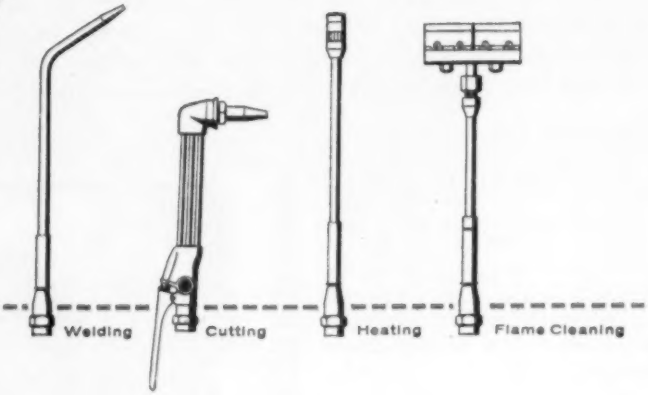

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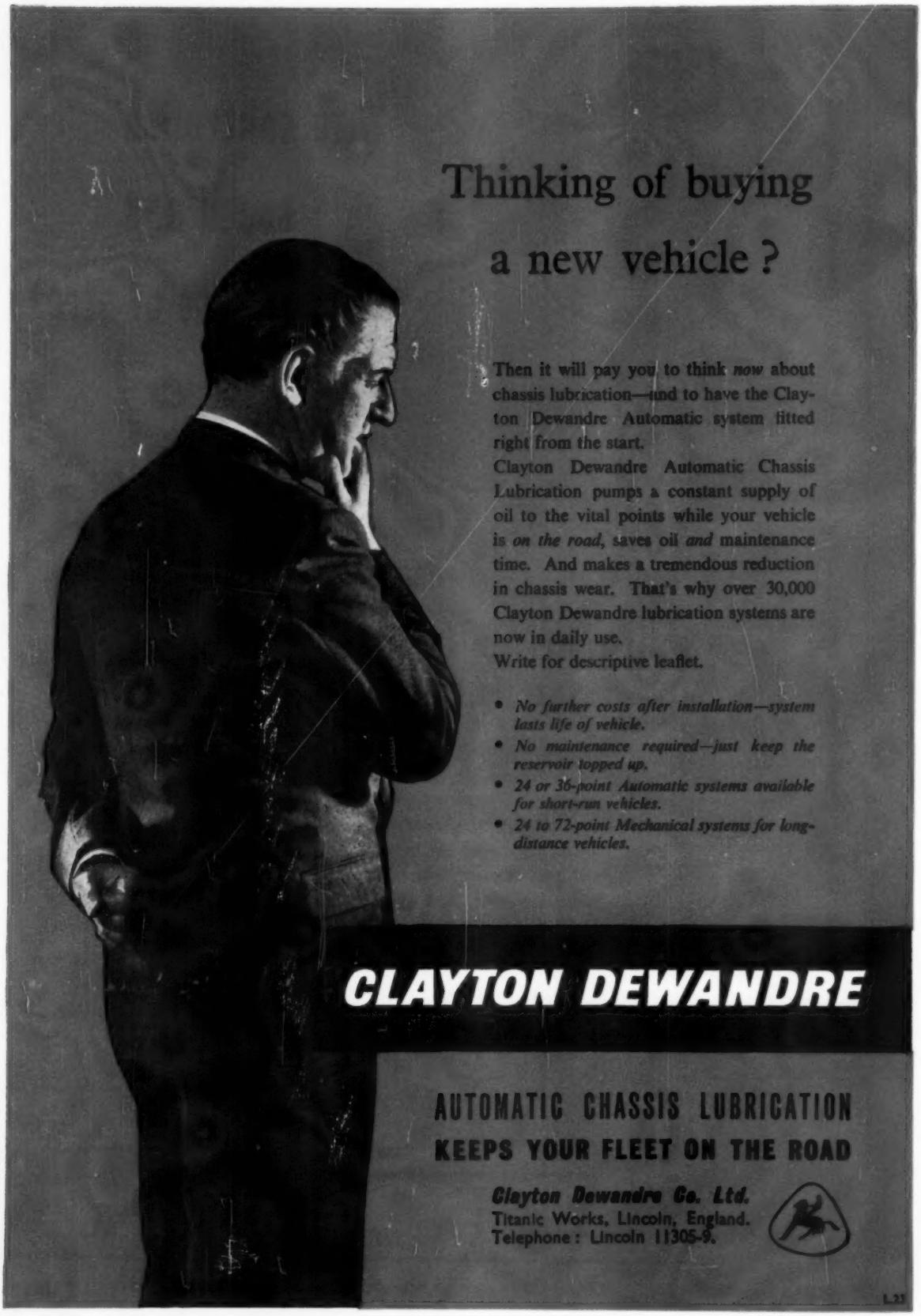
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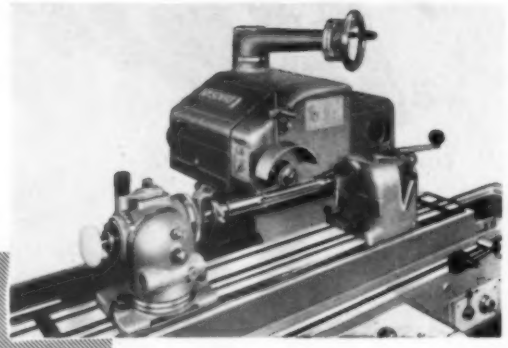

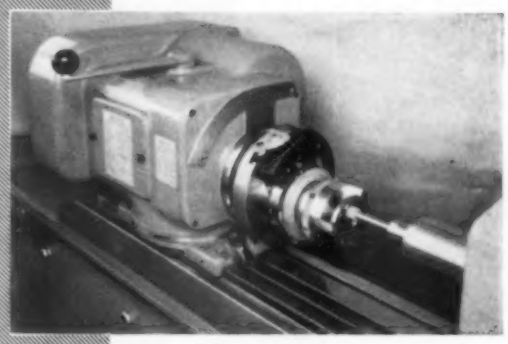

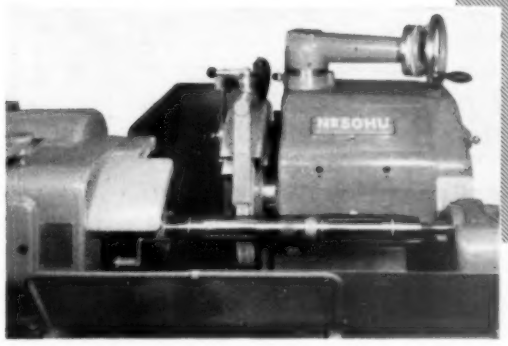

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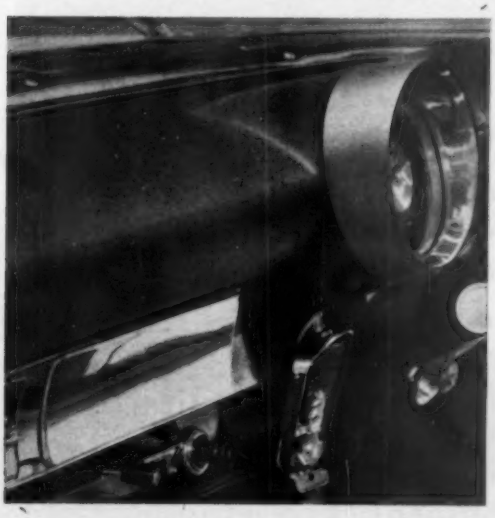

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This vice has its own hardened and ground steel table, parallel to the base, providing a permanent foundation for precision work.

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Reversible jaw plates for irregular shapes.

Standard range includes 4", 6" and 8" jaw widths.

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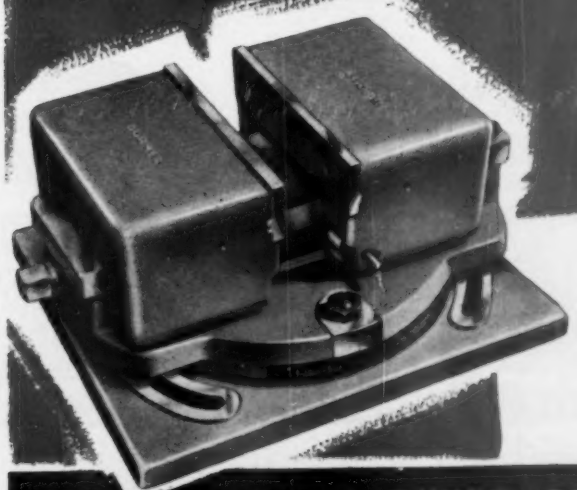

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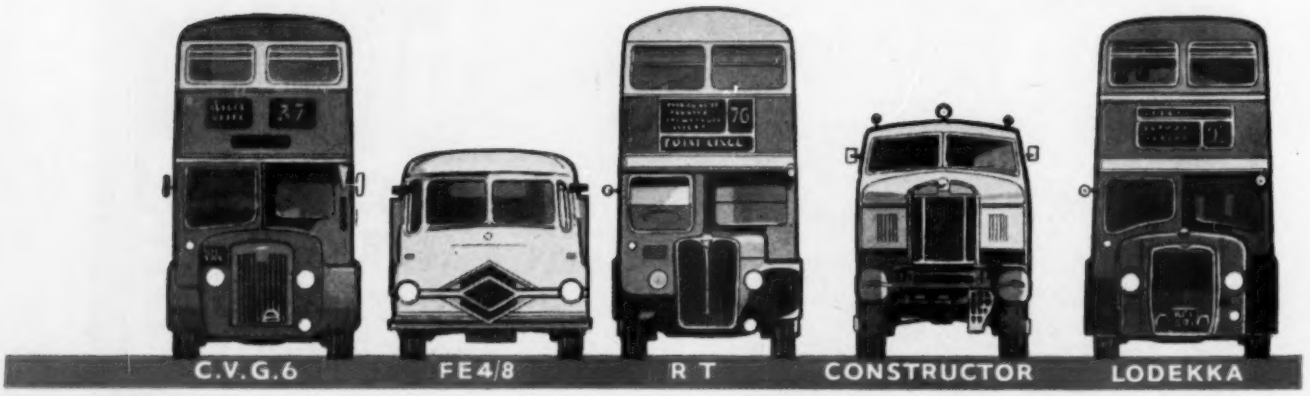

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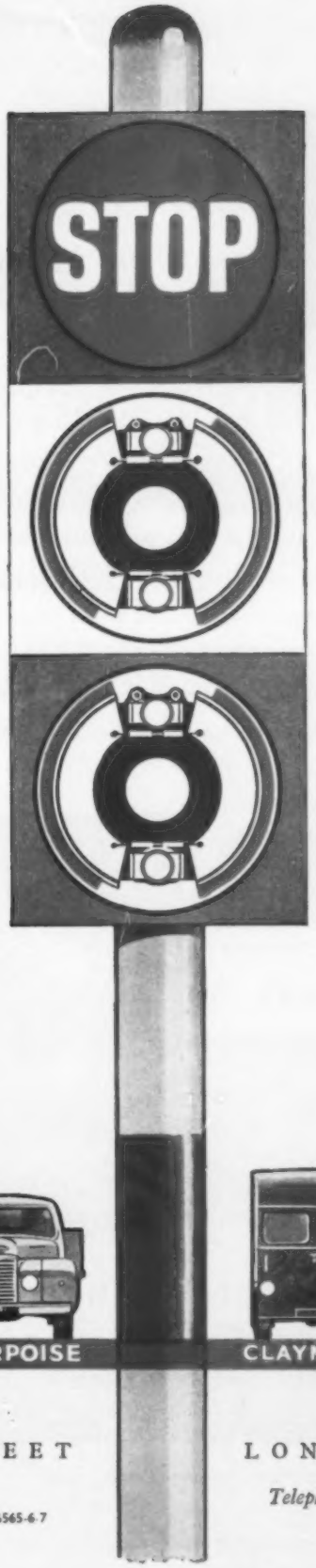

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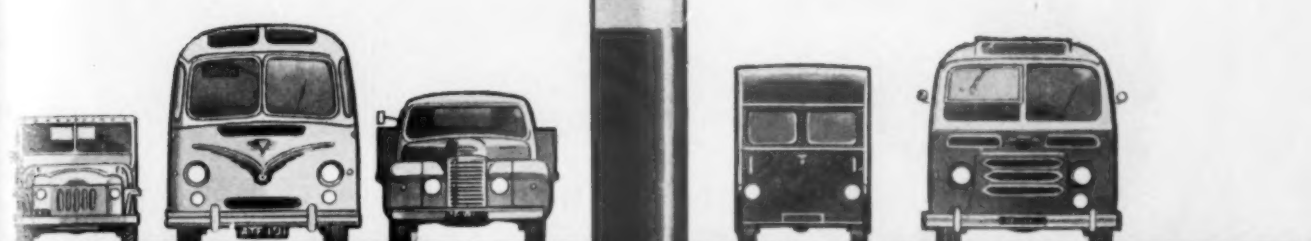

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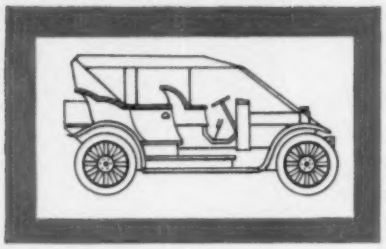

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The continuing success of Sterling Metals is due to their ability to supply castings of the highest quality in the desired quantities at the right time.

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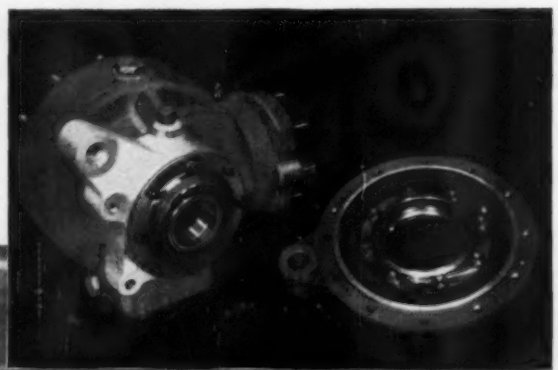
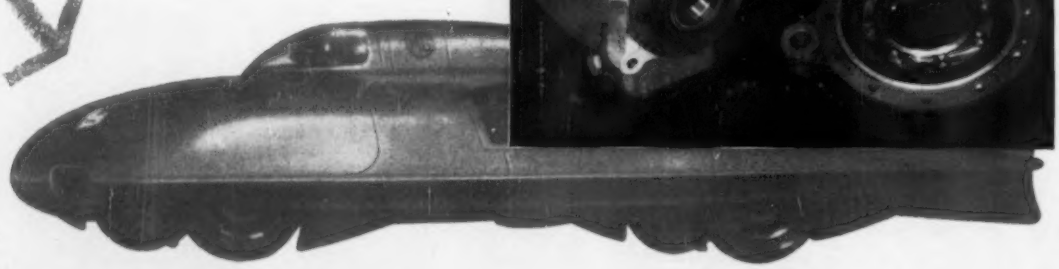
Sterling Metals are at your service

Spiral-bevel drive casing and cover in Z5Z Magnesium-Zirconium Alloy for record-breaking M.G. EX.181 car. By courtesy of British Motor Corporation.





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for fast, automatic face and diameter grinding

M.S.O. type F.H.S. Grinding Machine fitted with magazine feed and automatic unloading device.

Components requiring grinding on face and diameter or cylindrical portions and shoulders, can be produced automatically at fast rates on the M.S.O. type F.H.S. machine. This grinder has a fixed wheelhead which is offset 30° and carries the grinding wheel on the right-hand side. The angular setting ensures high finish of the shoulder. Height of centres 5⅛". Maximum diameter ground 4".

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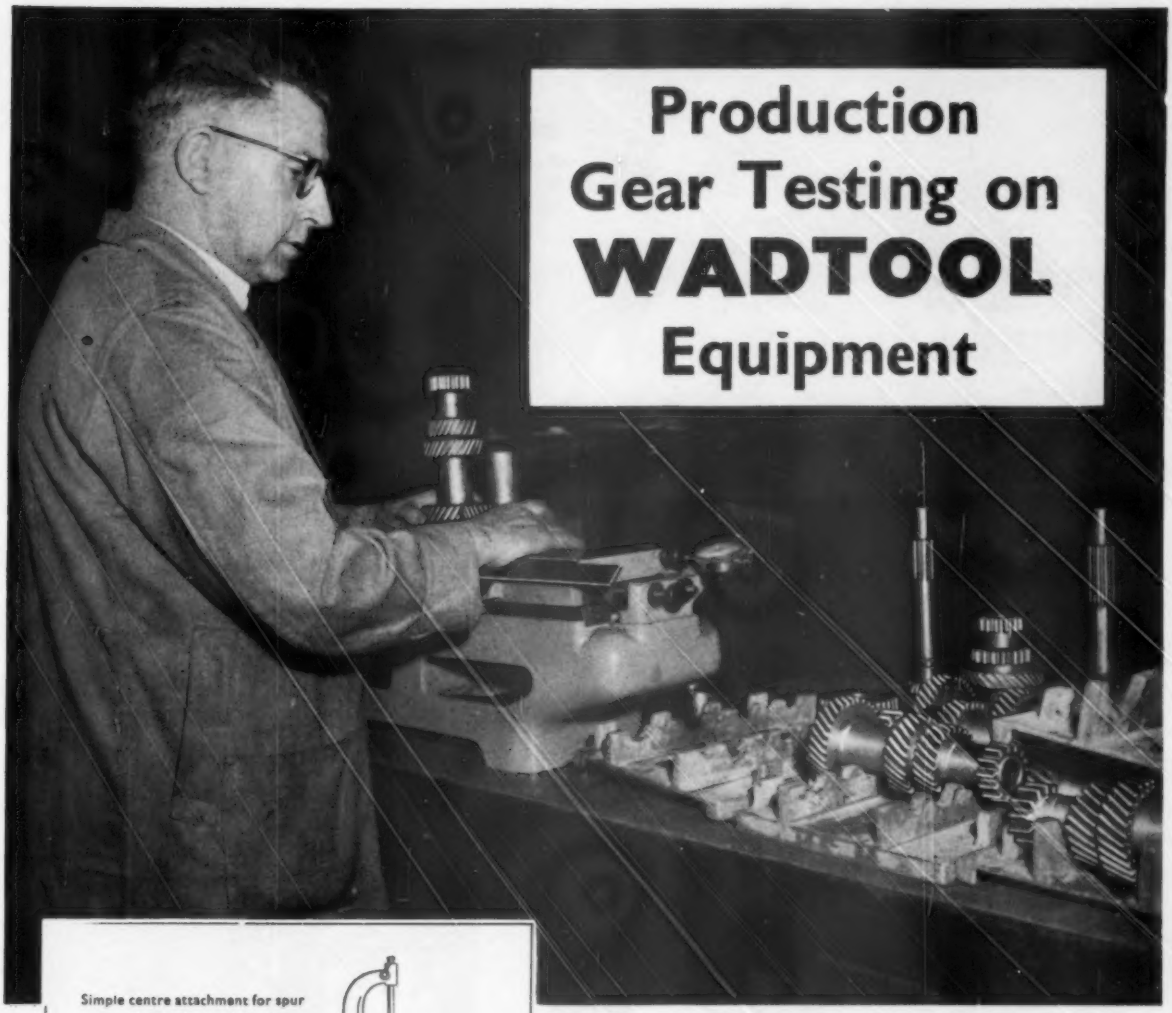
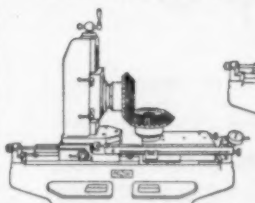
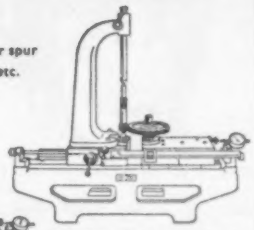
IF 275

Production Gear Testing on WADTOOL Equipment



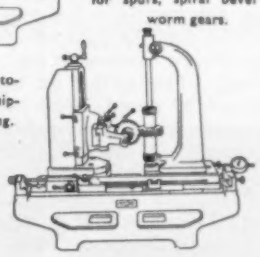
Simple centre attachment for spur gears integral with shaft, etc.





Indexing centres attachment for spurs, spiral bevel or worm gears.

The two attachments together with special equipment for worm testing.



Photograph by courtesy of Morris Motors Ltd., Engines factory, Coventry.

The Wadtool Gear Tester provides a quick, accurate and economic method of checking production gears—that's why it is used by mass production organizations like motor manufacturers.

Two saddles mounted on guide ways carry the gears to be checked. One saddle is clamped in position and the other 'floats' on steel balls and is kept in contact by spring pressure. Movement of this saddle caused by irregularities in the gears is recorded on a dial indicator.

Attachments are available for accommodating various types of gears. The machine illustrated has maximum centres of 10".

A similar Gear Tester is now available with maximum centres of 20".

Write today for full details.

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HF 132

what, no nuts? . . .

Nuts to use nuts? Well, not exactly, but the fact that the Tapping Screw obviates the use of nuts is just one of its distinct advantages over the conventional Machine Screw. There's the saving in time to consider too. And cost. And there's no doubt whatever that the tapping screw makes for a better job all round. With its self-locating point the tapping screw forms its own thread thereby eliminating a separate and expensive tapping operation. Obviously it makes for easier assembly, is stronger, cheaper and faster. Safer too when the Phillips recessed head is specified, designed for power driving without damage to worker or job. You'll be well advised to change over to Tapping Screws. Nothing nuts about that !

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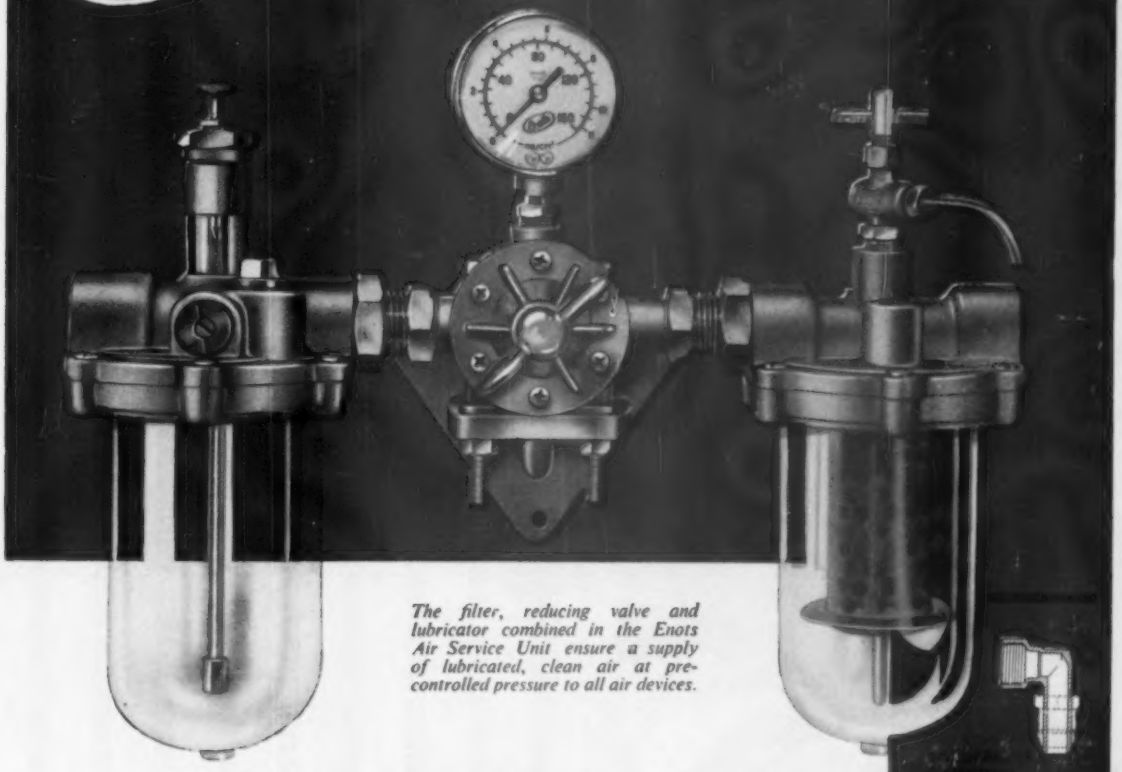
SLOTTED AND PHILLIPS RECESSED HEAD MACHINE SCREWS AND TAPPING SCREWS • HIGH TENSILE HEXAGON HEAD BOLTS AND SETSCREWS
AIRCRAFT BOLTS, SCREWS AND RIVETS • SEMS • RIVNUTS • CUSTOM DESIGNED COLD FORGED FASTENERS • ALEX SCREWPLUGS

Enots

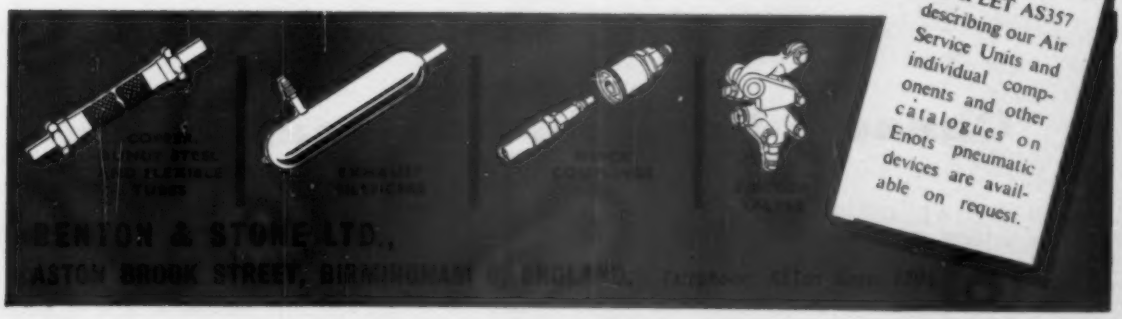
AIR SERVICE UNITS and PNEUMATIC EQUIPMENT

improve efficiency and reduce production costs



The filter, reducing valve and lubricator combined in the Enots Air Service Unit ensure a supply of lubricated, clean air at pre-controlled pressure to all air devices.

A pressure reducing valve fitted to almost any pneumatic device will save its cost in a very short time by reducing air consumption. At how many points in your works are you using full line pressures of up to 100 lb. per sq. inch where 80, 60 or even lower pressures would be adequate? Savings are more or less in direct proportion to pressure reduction.



LEAFLET AS357 describing our Air Service Units and individual components and other catalogues on Enots pneumatic devices are available on request.

ENTON & STONE LTD.,
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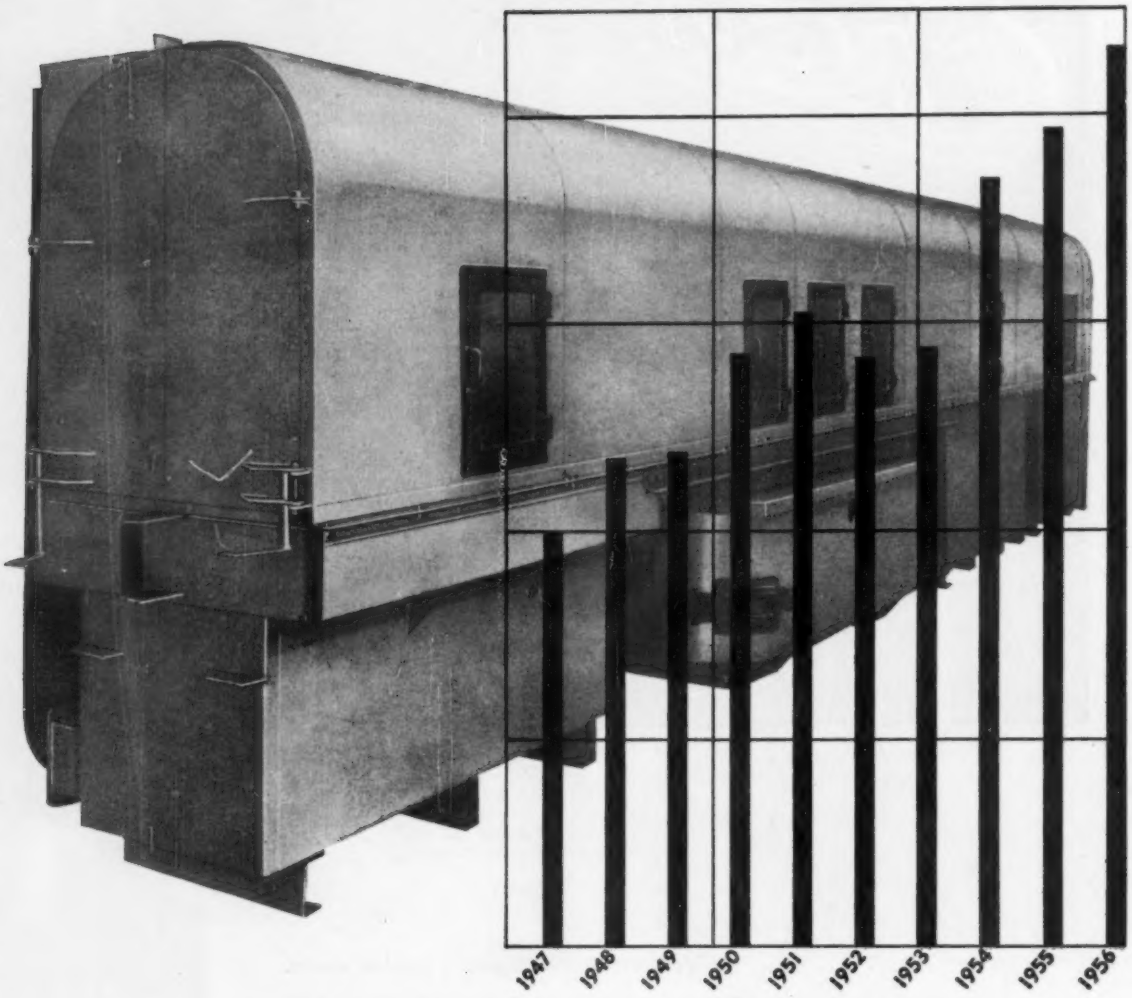
Hard Facts



SOME PEOPLE say that "the salt bath method of casehardening is a back number".
Well, our sales of 'Cassel' carburising salts have been rising spectacularly over the last ten years. Look at the graph—it speaks for itself. Last year we sold more 'Cassel' salts than we'd ever done before; and it wasn't just that existing customers were using more — we had many *new* customers last year. So there it is: for a "back number", the salt bath method seems to be doing pretty well. It's not surprising — the salt bath method gives you simplicity of control and high metallurgical quality. And we like to think we have something to do with its evergrowing popularity — after all, you can't do better than

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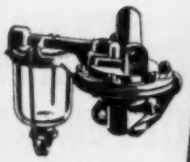
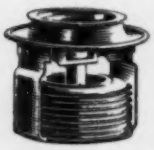
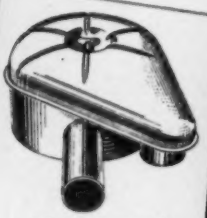


AC Fuel Pumps

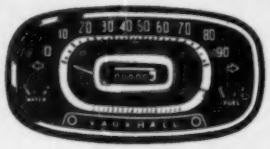


AC Thermostats

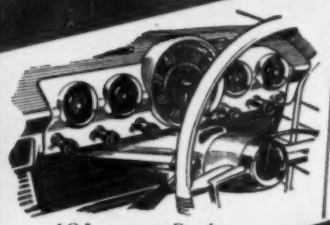


AC Air Cleaners & Silencers

DELCO-REMY Oil-Filled Coils



AC Instruments



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Virtually every British vehicle has one or more AC-Delco products designed into it at drawing board stage. AC-Delco research engineers will gladly help when you are planning a new design or modifying an existing one.

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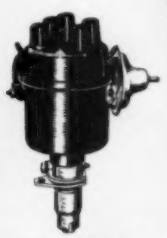
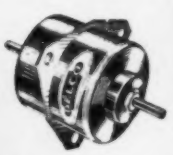
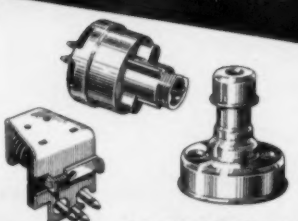


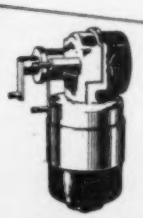
DELCO-REMY Ignition Distributors



DELCO Electric Motors



DELCO-REMY Switches



DELCO Electric Screen Wipers

A trustworthy service—

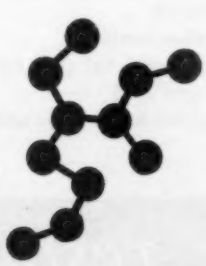
The efficient machining of metals

presents problems of such importance that we, as specialist oil manufacturers, undertake considerable research work in order to arrive at facts that will permit the selection of Cutting Oils on a scientific and thoroughly reliable basis. It frequently happens in the machine-shop that this selection is not based on any sound consideration at all, different plants performing the same operation on the same machine and metal, often showing wide variation in type of Cutting Oil used and results obtained.

Cutting Oils to meet present-day requirements can be made available, some standard, some very special, and satisfactory machining cannot be accomplished without them. With the increasing use of special steels and advanced machining methods the old 'hit and miss' methods will not do.

Our organization is tireless in basic research to ascertain the usefulness of various constituents in Cutting Oils and to determine their influence on current machining problems.

We have been engaged in metal cutting oil development for nearly sixty years and are recognized as the foremost authority.



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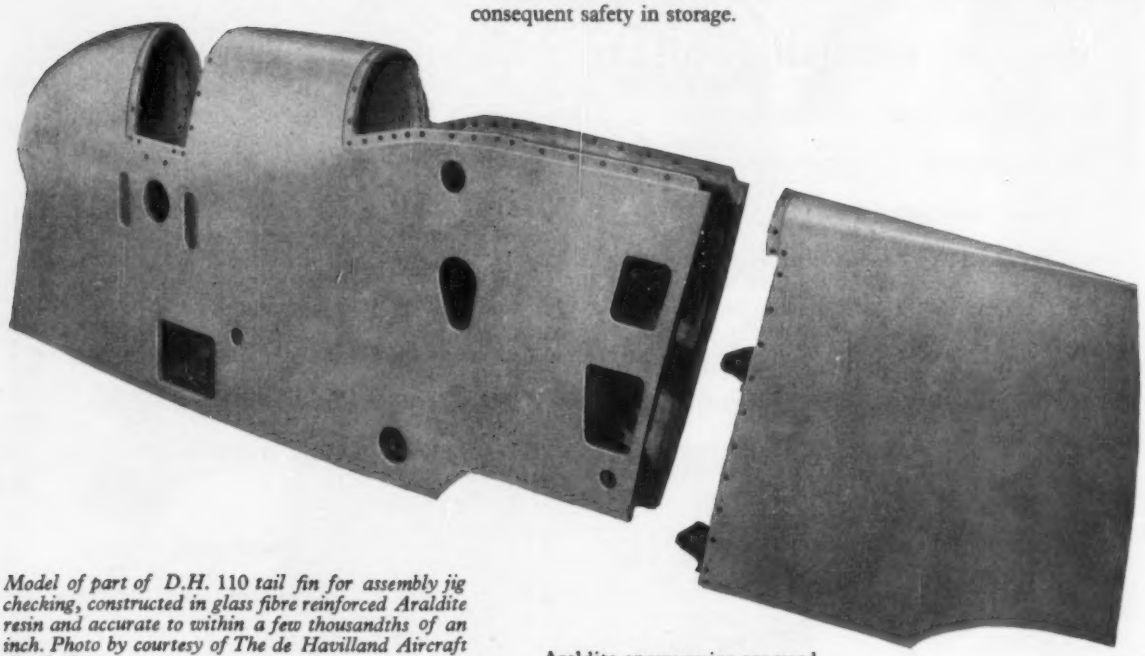
Tooling techniques with Araldite resins are being adopted more and more widely. Models, jigs, fixtures, patterns and metal-forming tools, including hammer forms, stretch blocks, rubber press tools, drop-hammer and draw dies, can all be made by simple methods with virtually no machining and a minimum of skilled manual work. Araldite tooling resins are used as gravity cast mineral-filled mixtures or with glass fibre mat or woven reinforcement, the latter providing strong, dimensionally stable, but lightweight surfaces and structures. Advantages of Araldite in tool-making include ease and speed of production, low production costs, light weight and ease of handling, negligible shrinkage on curing, accuracy of reproduction, dimensional stability, durability, resistance to cutting-oils and die lubricants, resistance to moisture and chemical attack, with consequent safety in storage.



Model of part of D.H. 110 tail fin for assembly jig checking, constructed in glass fibre reinforced Araldite resin and accurate to within a few thousandths of an inch. Photo by courtesy of The de Havilland Aircraft Co. Ltd.

The recommended techniques are simple and easily acquired. Full details and practical assistance are available upon request. May we send you a copy of our new publication on Araldite for tools, jigs and fixtures?

Araldite epoxy resins are used

- **for bonding metals, porcelain, glass, etc.**
- **for casting high grade solid electrical insulation**
- **for impregnating, potting or sealing electrical windings and components**
- **for producing glass fibre laminates**
- **for making patterns, models, jigs and tools**
- **as fillers for sheet metal work**
- **as protective coatings for metal, wood and ceramic surfaces**

Araldite *epoxy resins*

Araldite is a registered trade name

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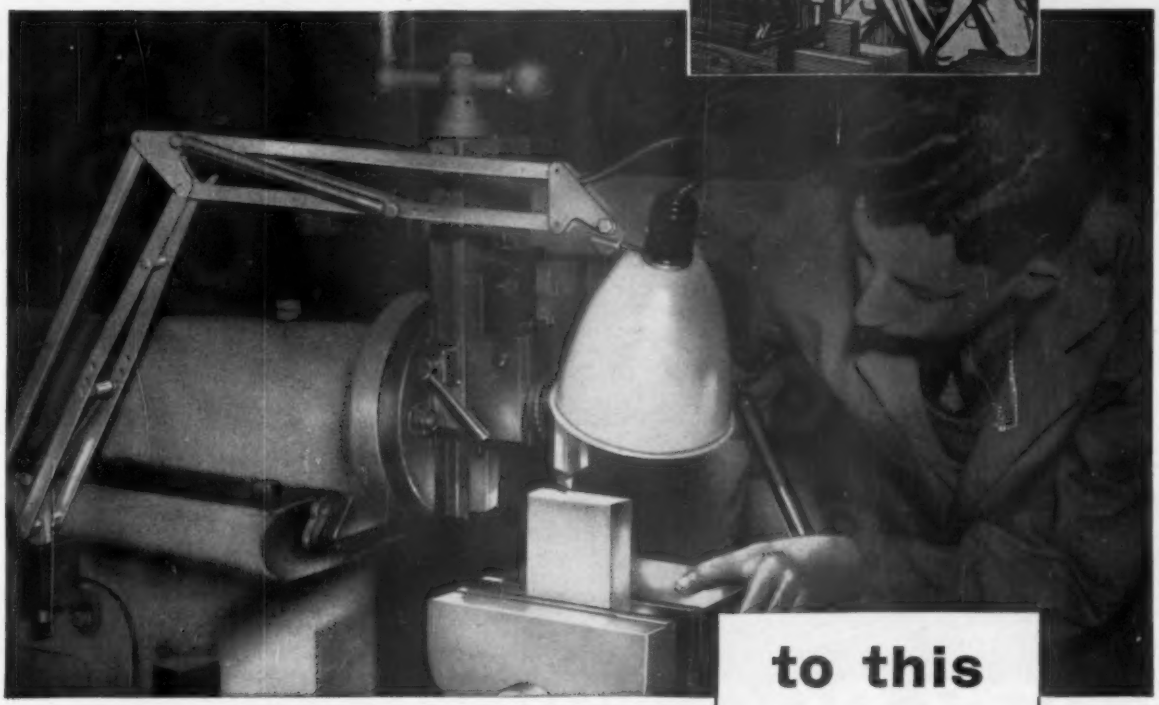

to this

and step up production . . .

For working within close limits, an Anglepoise is simply indispensable. However good a worker and his eyes may be, he must see the job. This applies in all fine work, drilling, assembling, etc., where instantly adjustable close-to-the-job lighting is a sheer necessity.

Anglepoise throws a clear, concentrated light right on and into the work, not in the operator's eyes, follows the job from any position or angle, degree by degree, at a finger-touch and 'stays put' in any required position—and out of the way when not needed. It needs only a low-powered bulb for high-class results—a big saving on the lighting bill (it can be supplied with a small shade for low voltage systems). Why not learn more about this fine lamp by sending for Booklet A

TERRY Anglepoise *Regd.* **LAMP**

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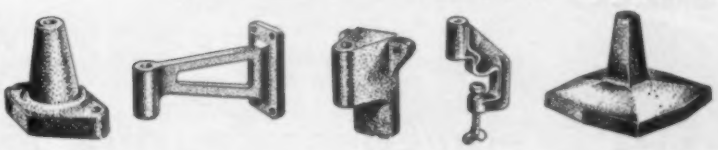
*** A SUGGESTION FOR MACHINE MANUFACTURERS:—**
Why not fit your products with Anglepoise? We will submit samples on approval.



Some of the alternative bases for all models

MT30

198,000 MILES
IN 5 YEARS

– and still no need for a re-bore

W. F. Miner and Sons operate a long distance haulage fleet based at Widecombe-in-the-Moor, Devon. Recently they examined their 7-ton type QX Commer which had run on Shell X-100 30 from new and had then 198,000 miles to its credit. When the sump was removed the crankcase and internal compartments were found to be so clean and free from sludge that the sump was replaced without any work being done. Next the cylinder head was removed and cylinder bore wear was measured and found to be less than 1/1,000 of an inch wear. "In five tough working years, the only repairs done to this vehicle were to replace three exhaust valves", comments Mr. Miner. "It proves the wisdom of using only Shell X-100 for petrol engined commercial vehicles run under arduous conditions".

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X-100
MOTOR OIL

FOR LONGER PETROL ENGINE LIFE

SUSPENSION UNITS

for the HEAVY VEHICLE

HEAVY-DUTY CONE BUSHES

Accommodating pivotal movements such as those in suspension linkage and spring pivots, these bushes are relatively free torsionally, adding but little to the spring stiffness. They are very stiff axially and radially and support heavy loads.

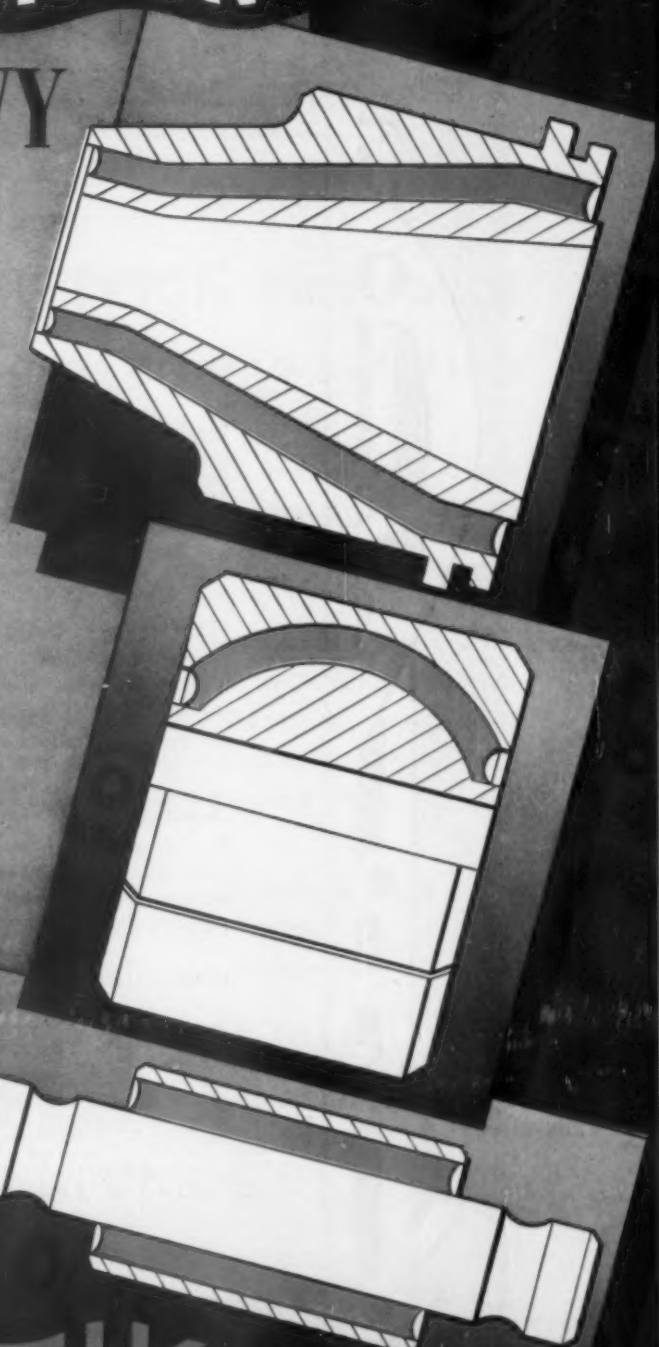
SPHERILASTIK BEARINGS

Permitting universal pivotal movements combined with large loads, Spherilastik bearings are being used with great success on a number of new suspension systems. Rubber is bonded to the spherical inner member and to the outer member which is in three segments. Force-fitting in the housing pre-loads the rubber to increase life and load capacity.

ULTRA-DUTY SHACKLE PINS

These are made in two types, one as illustrated and the other a still heavier duty type. They are giving amazingly long mileages in spring shackles on heavy vehicles.

Whatever your suspension, transmission or vibration problems may be, our engineers are always at your disposal.



METALASTIK

METALASTIK LTD., LEICESTER

198,000 MILES
IN 5 YEARS

– and still no need for a re-bore

W. F. Miner and Sons operate a long distance haulage fleet based at Widecombe-in-the-Moor, Devon. Recently they examined their 7-ton type QX Commer which had run on Shell X-100 30 from new and had then 198,000 miles to its credit. When the sump was removed the crankcase and internal compartments were found to be so clean and free from sludge that the sump was replaced without any work being done. Next the cylinder head was removed and cylinder bore wear was measured and found to be less than 1/1,000 of an inch wear. "In five tough working years, the only repairs done to this vehicle were to replace three exhaust valves", comments Mr. Miner. "It proves the wisdom of using only Shell X-100 for petrol engined commercial vehicles run under arduous conditions".

SHELL
X-100
MOTOR OIL

FOR LONGER PETROL ENGINE LIFE

SUSPENSION UNITS

for the HEAVY VEHICLE

HEAVY-DUTY CONE BUSHES

Accommodating pivotal movements such as those in suspension linkage and spring pivots, these bushes are relatively free torsionally, adding but little to the spring stiffness. They are very stiff axially and radially and support heavy loads.

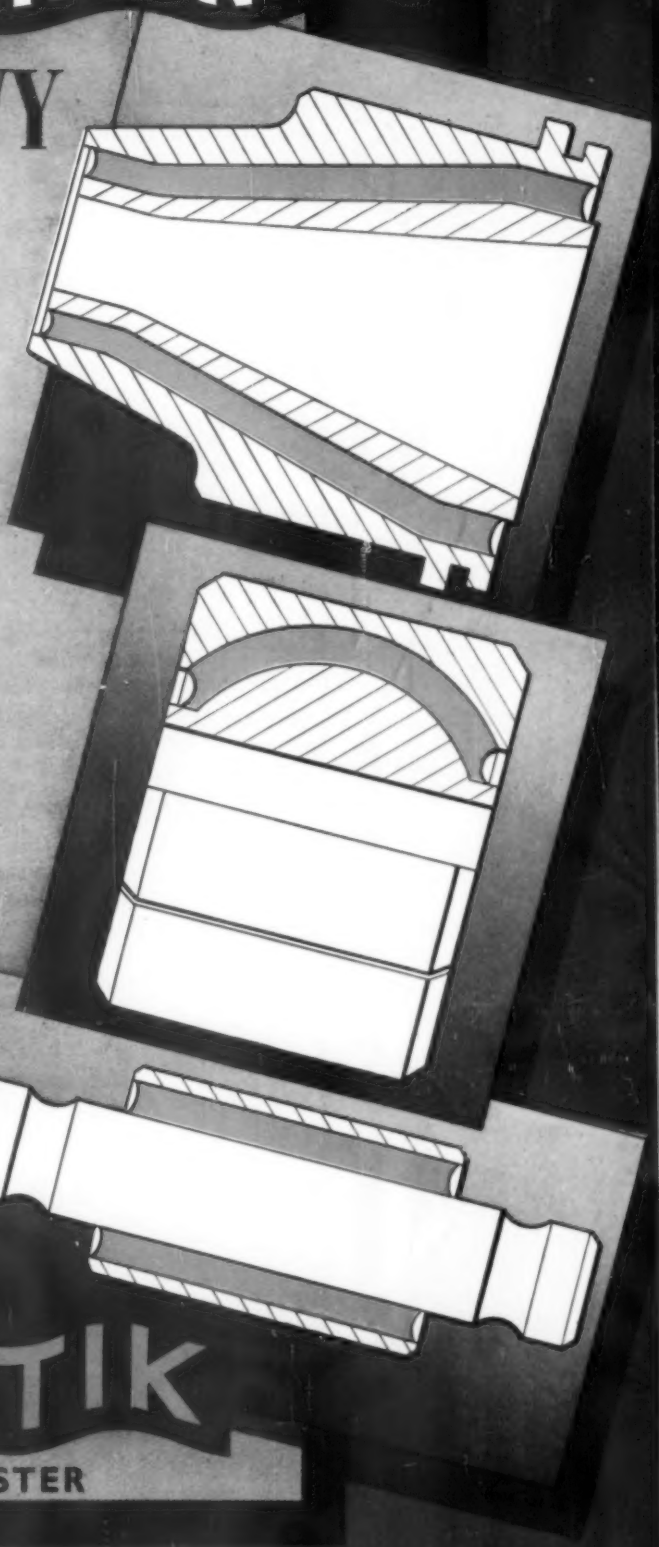
SPHERILASTIK BEARINGS

Permitting universal pivotal movements combined with large loads, Spherilastik bearings are being used with great success on a number of new suspension systems. Rubber is bonded to the spherical inner member and to the outer member which is in three segments. Force-fitting in the housing pre-loads the rubber to increase life and load capacity.

ULTRA-DUTY SHACKLE PINS

These are made in two types, one as illustrated and the other a still heavier duty type. They are giving amazingly long mileages in spring shackles on heavy vehicles.

Whatever your suspension, transmission or vibration problems may be, our engineers are always at your disposal.



METALASTIK

METALASTIK LTD., LEICESTER

Widening the choice of
resilient jointing materials
LANGITE
Langite — which for more than thirty years has been used so extensively wherever there is an oil joint to be kept tight — utilizes the natural resilience of cork, bonded together by an original process.
NEOLANGITE
like Langite, embodies cork, but in this case is bonded with appropriate synthetic rubbers.
NeoLangite is used extensively on transformers, aircraft, motor vehicles, etc.; it has a considerable mechanical strength and recovery after compression.
Chingford cork 'jointing' material
For less critical applications, cost may be saved by the use of this material, made alongside Langite but to a less exacting specification.
All other types of non-metallic seals, compressed asbestos fibre, impregnated paper etc. can be supplied.
CORK MANUFACTURING CO. LTD., SOUTH CHINGFORD, LONDON E.4
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JOINTING MATERIAL
RESISTS OILS, SPIRITS, PETROL, BENZOL ETC.

Metrovick VERTIVICK electrodes

for vertical and overhead welding

The Vertivick is a superior all-position electrode for mild steel welding, possessing exceptional qualities for use in the vertical and overhead positions, yet retaining all the essential features for downhand welding.

SLAG-FREE WELDS—As the arc length of the Vertivick electrode is not critical, sound slag-free welds, with excellent mechanical properties, can be achieved even with inexperienced operators. The slag, being sufficiently fluid, clears quickly from the molten pool when welding vertically and there is no tendency to flood the arc when downhand welding. Slag can easily be cleaned from the root run of vee-butt welds.

FINISH—Vertivick electrodes have a stable arc which is easily struck and gives a smooth and regular weld appearance with a close rippled finish free from spatter and undercut. Downhand fillets are flat in shape and show an excellent " wash-on ".

APPROVALS—Approved by the Admiralty, Lloyd's and the Ministry of Transport and Civil Aviation for welding of mild steel in all positions, also by the Ministry of Supply for welding Carbon Manganese steels (carbon 0.26% max.) Class FV.1050/IV British Standard Classification E317.

METROPOLITAN-VICKERS
ELECTRICAL CO LTD TRAFFORD PARK MANCHESTER 17

An A.E.I. Company

Metrovick Electrodes for Every Purpose

L/P703

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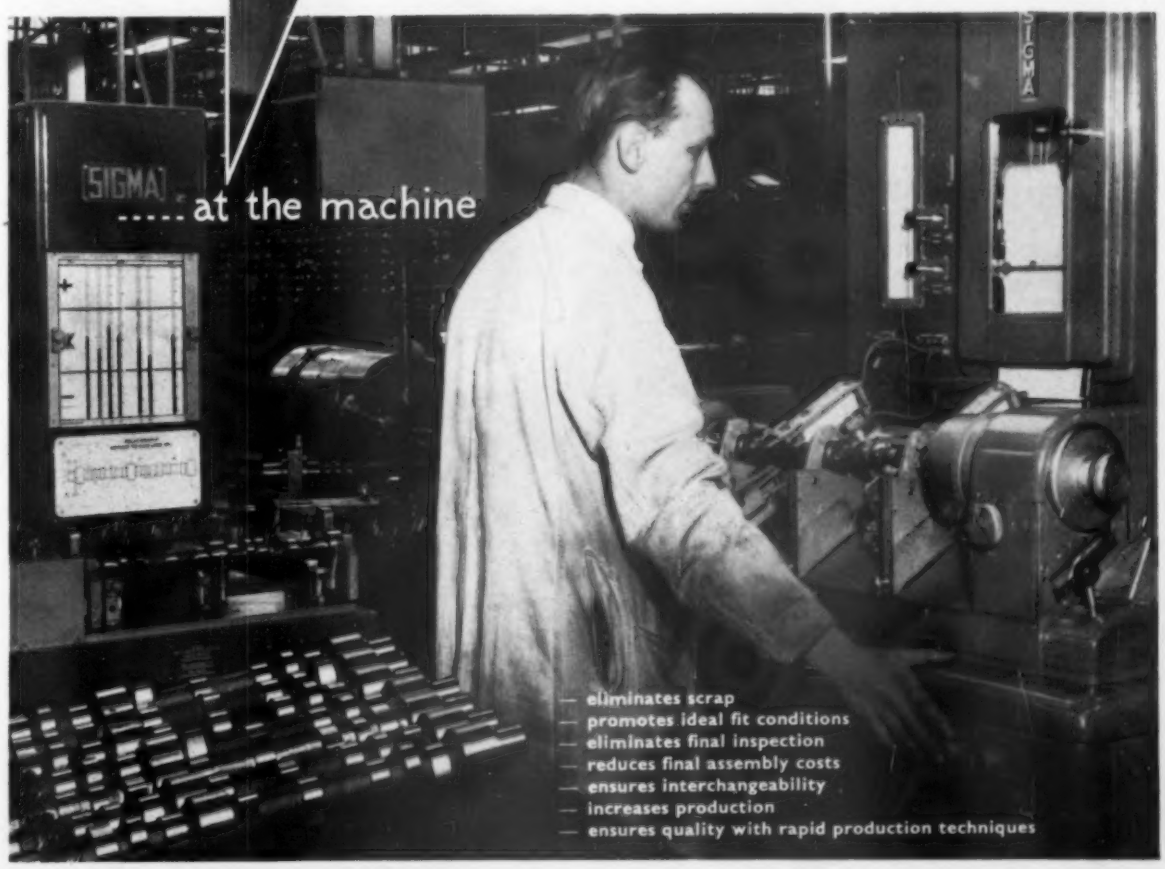

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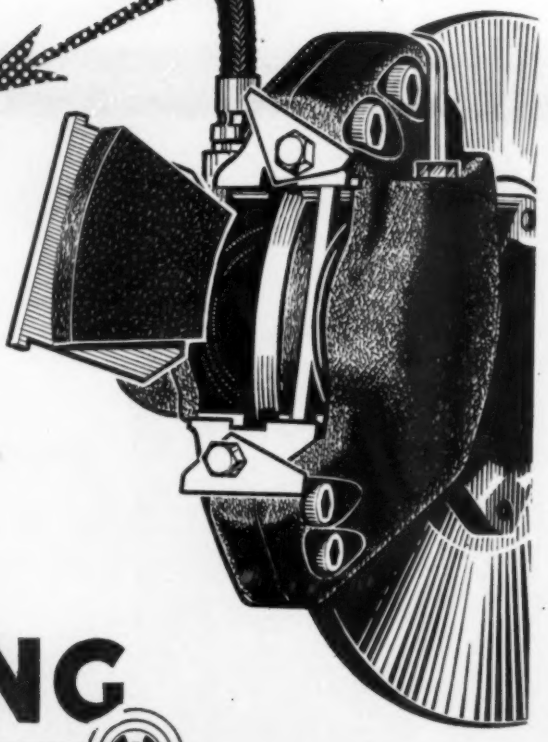
make them outstandingly successful for modern cars and vehicles



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PATENTED **DISC BRAKES**

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With chisel and mallet the sculptor's hands create a masterpiece from solid stone. The tools of his craft, like many others, owe much to correct heat-treatment. And that's where Wild-Barfield come in. We pioneered the use of the centrifugal fan, and forced air circulation is still the best available means of tempering, secondary hardening, etc. Correct heat-treatment is only a means to an end, but it does require properly designed furnaces. We've been making them for over forty years.

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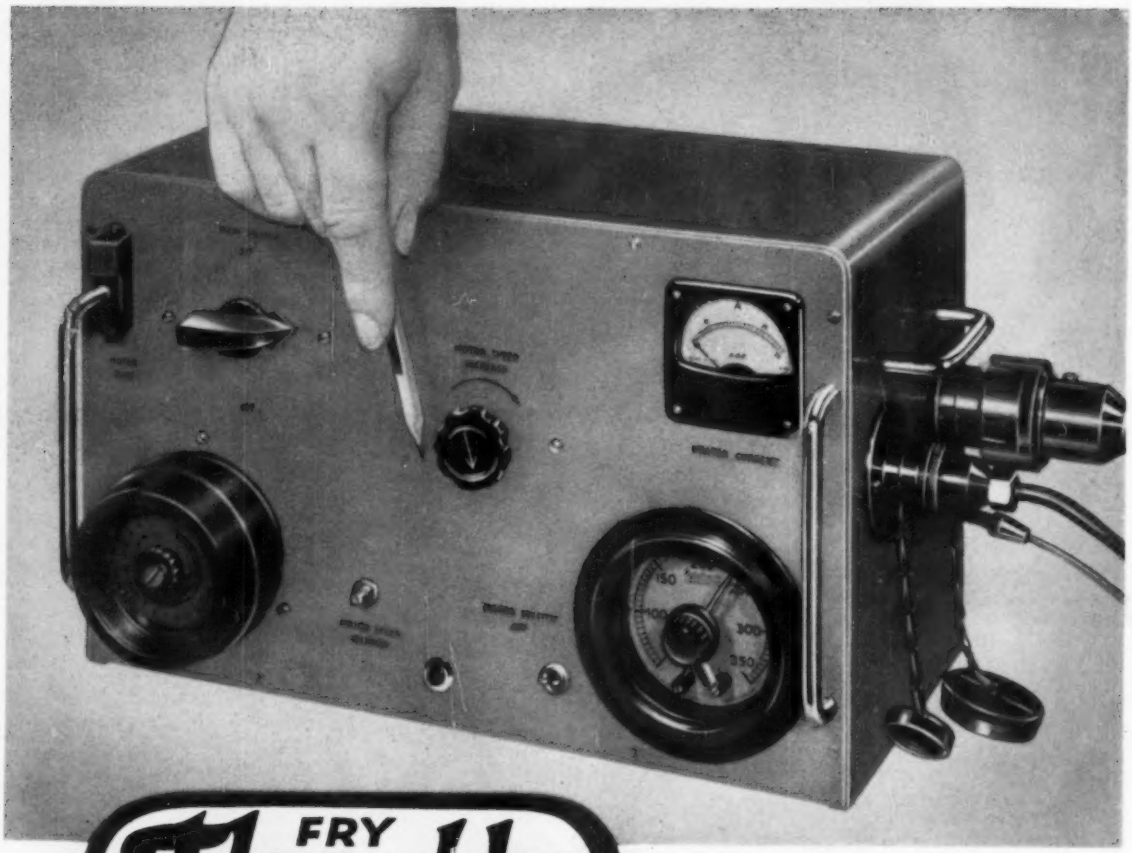
Soldering Printed Circuits — *without tears*



FRY Flowsolder MK. II.

TRADE MARK

Trouble free, fast soldering, with no joints missed or excessively loaded—that's what you can expect from Flowsolder Mk. II. This versatile equipment—widely used in this country and in great demand in America—operates as fast as your production line, and features:

- **Automatic angled entry and exit for panels**
- **Straight—line conveying**
- **Continuous *clean* solder flow**
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- **Takes panels of any length**
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Invitation

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Demonstrations daily from Tuesday, 15th April to Friday 18th April. 10 a.m.—6 p.m.

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QUALITY STEELS
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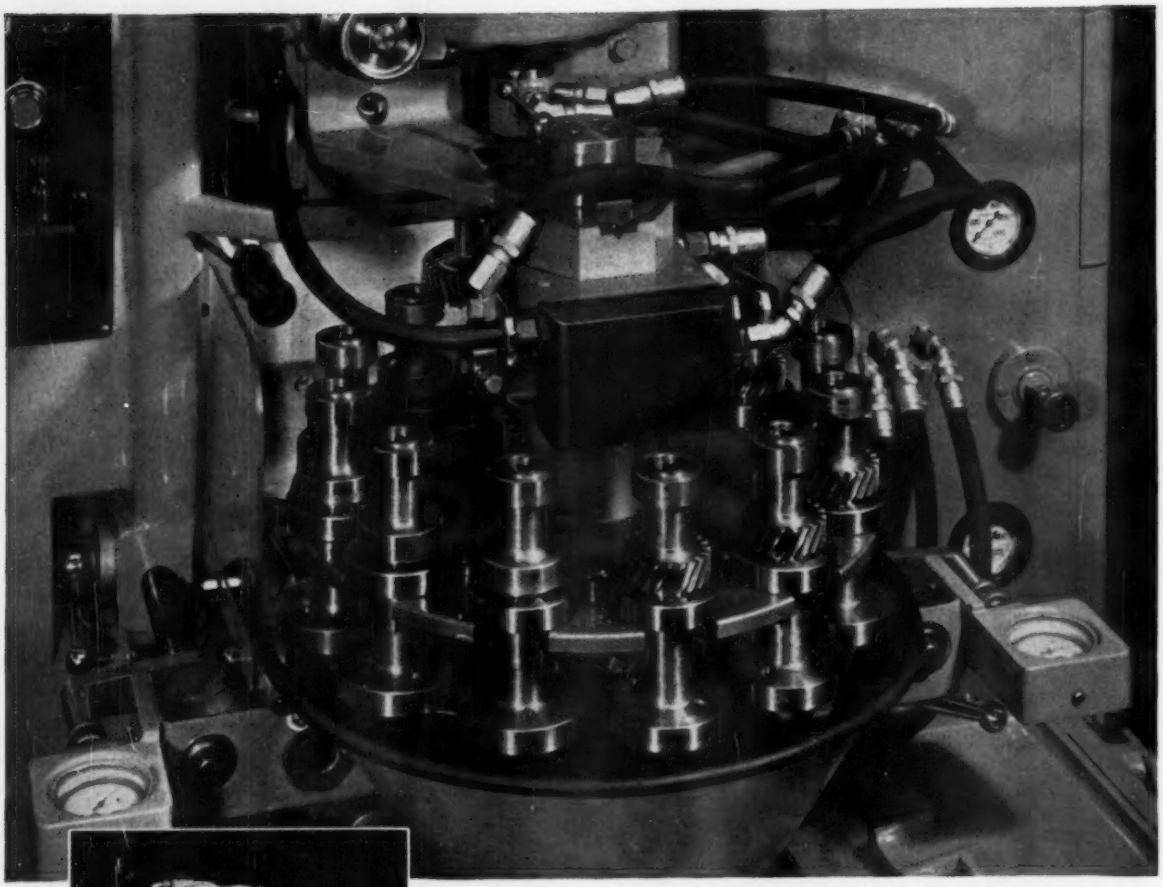

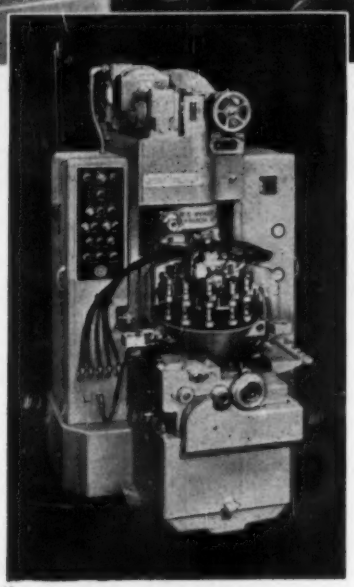

Above:
A battery of 12 automobile layshaft gears being generated. Cycle time per gear is 3¼ minutes.

SYKOMATIC

MAGAZINE LOADING GEAR GENERATOR

With the Sykomatic, W. E. Sykes Ltd have taken a really big step forward in automatic gear production.

The controls are simplicity itself. Once the rotary turret magazine has been loaded with blanks, gears can be cut in one *automatic* cycle without any further attention from the operator.

What is more, the Sykomatic requires a minimum of floor space, and can easily be accommodated in a small machine shop.

If you have quantities of similar gears to be cut, it will pay you to investigate the Sykomatic. Write your name and address in the margin of this advertisement and send it to:—

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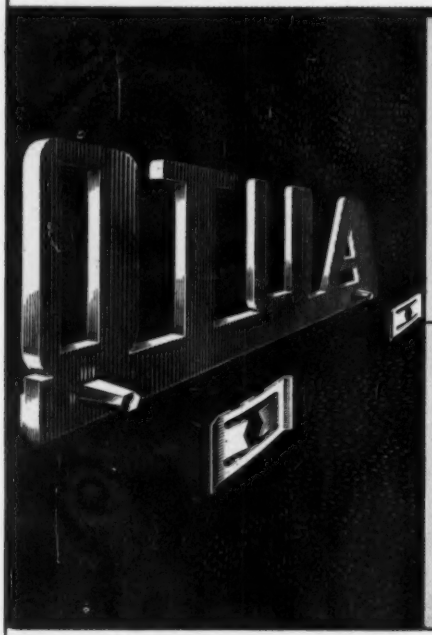
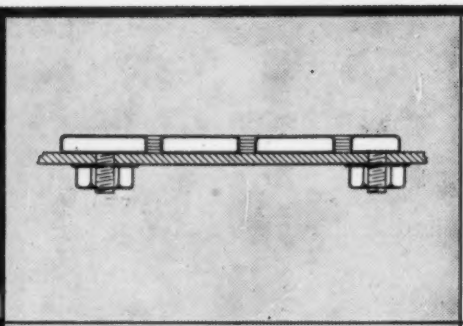
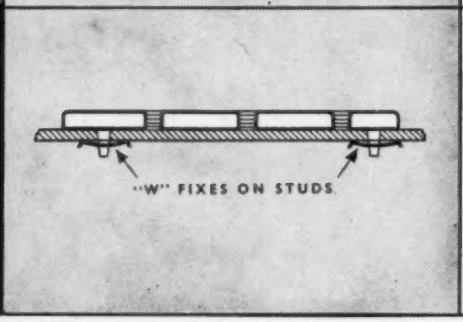




OLD WAY

Threaded studs were spot welded (or inserted if die-cast) to the name-plate. To hold this in position, washers and nuts were laboriously assembled with great difficulty especially on blind applications.



THE SALTER WAY

Studs are cast in with the nameplate, and the Fixes are simply pushed on, even on blind applications. The whole is firmly retained with an even spring tension.

save material–reduce assembly time–**cut costs**

When it's a question of assembling components in any engineering field, Salter Retainers are the answer. They replace nuts and bolts, screws, cotter pins, and eliminate expensive threading and machining operations. A large standard range is at your immediate disposal, and we should welcome the opportunity to assist in developing special retainers to solve your problems.

Send for the Salter Retainer catalogue — no designer is complete without it.

NEATER – MORE POSITIVE – PERMANENT RETAINING

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Circlips · Fasteners · Retainers · Fixes

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H-W.444

If you can't go through GO OVER

After a survey of your plant, we produce a tailor-made plan. This and the estimate are free.

Are you compromising between the ideal production layout, and the realities of moving materials and components around your works? Far better to integrate the two requirements by installing a British MonoRail system. This permits overhead transfer at a controlled rate in any direction. Internal transport can therefore be fully linked with mechanical processes, while leaving maximum flexibility and economy of layout on the ground.

Advantages worth noting □ Uses 'free space' for conveyance and storage □ Switches, interlocks and lifts permit movement in three dimensions □ Choice of individually powered, fully automated or gravity drives □ Can accommodate any number of items per transit □ Transit rates from 2-150 ft./min. □ Negligible operational and maintenance costs □ Underslung system permits unobstructed transfer between parallel tracks □ System can be extended as required □ Any size of installation □ Excellent after-sales service

IF YOU WANT TO GET A MOVE ON

Send for the man with the MONORAIL plan

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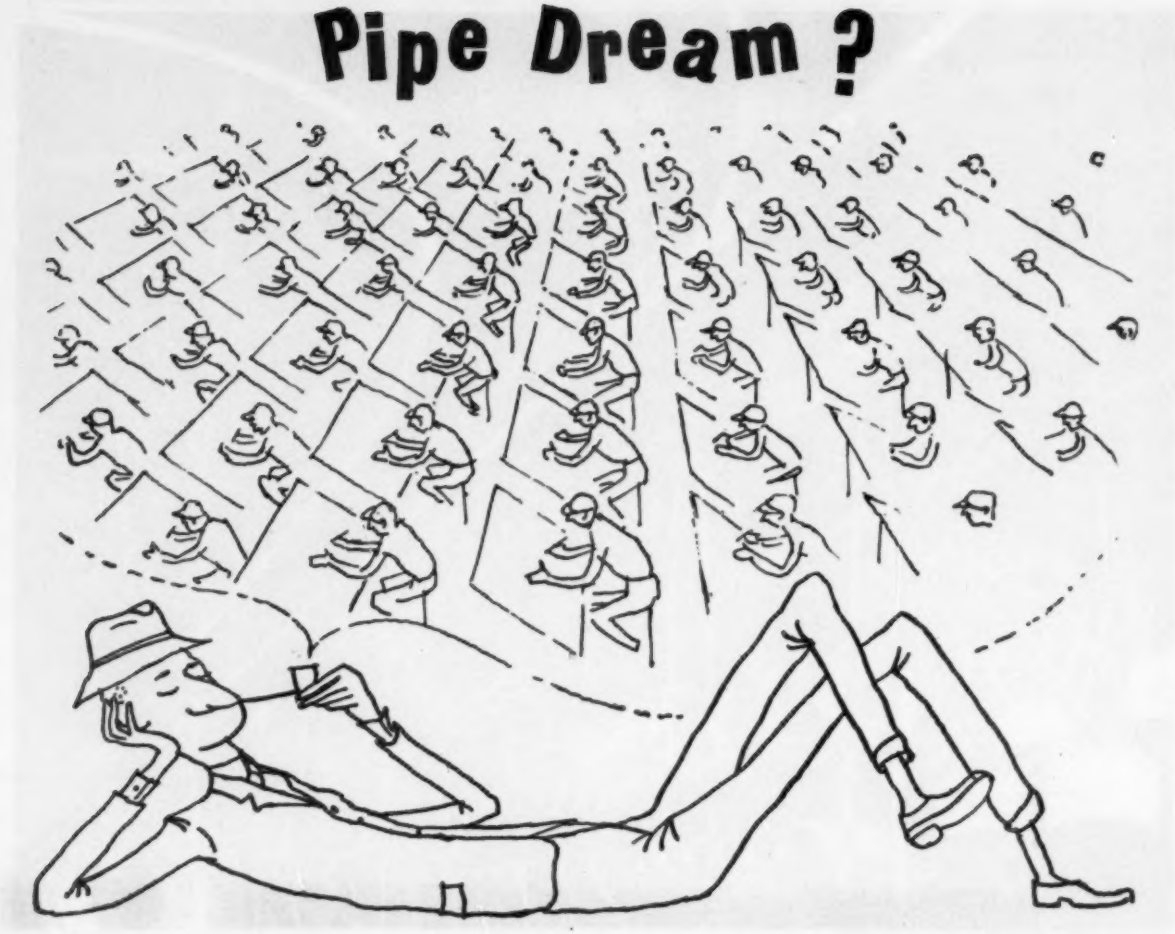
Pipe Dream ?



When you're dreaming up plans to increase production it's time to wake up to AZOFLEX. It's the *only* process to apply a controlled quantity of developer, thus ensuring optimum quality at all running speeds—and it's the only daylight reflex copying process. There are no dangerous chemicals and because no ducting is necessary to take away offensive fumes, machines are freely movable from place to place. Exposing, developing and print delivery are completely synchronised and output is virtually as fast as the operator. In plain language the AZOFLEX MODEL 42/63 can produce more than one hundred 20″ × 30″ prints an hour at a lower cost per print than you ever dreamed.

AZOFLEX MODEL 42/63 MARK II

Synchronised printing and developing machine. Capacity: cut sheets and rolls up to 42 in. wide. Printing speed: from 6 in. to 15½ ft. per minute. Dimensions: Height 50 in., width 71 in., depth 52 in. with delivery tray extended. Weight: approximately 850 lb.

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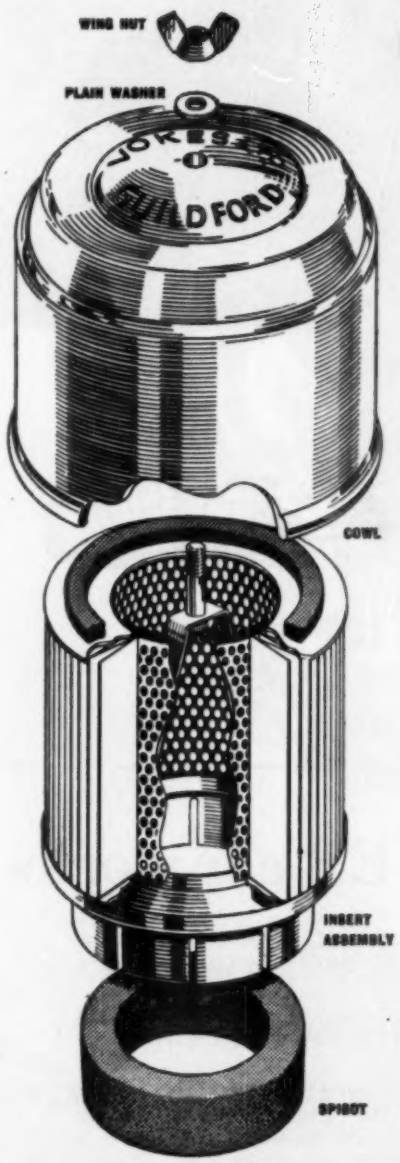
Vokes new paper element air intake filters



give over 99.9% efficiency in the 3-8 micron range

An internal combustion engine uses vast quantities of air—about 10,000 times as much air as petrol or fuel oil by volume—yet many units, such as powered road tools, small agricultural equipment, small stand-by power sets, cement mixers, compressors, etc., though often working in difficult and dirty conditions, have no air intake filtration at all. The Vokes high-efficiency paper element range of air intake filters has been designed for this type of application. With over 99.9% efficiency in the 3-8 micron range, they combine extremely high dust-collecting efficiency, ease of maintenance and replacement with low initial cost. The filter itself is a specially impregnated paper with plastic-sealed end caps. The standard range of sizes offers capacities from 10 to 145 c.f.m. Literature giving more details of this simple, inexpensive, and efficient filter is available on request.

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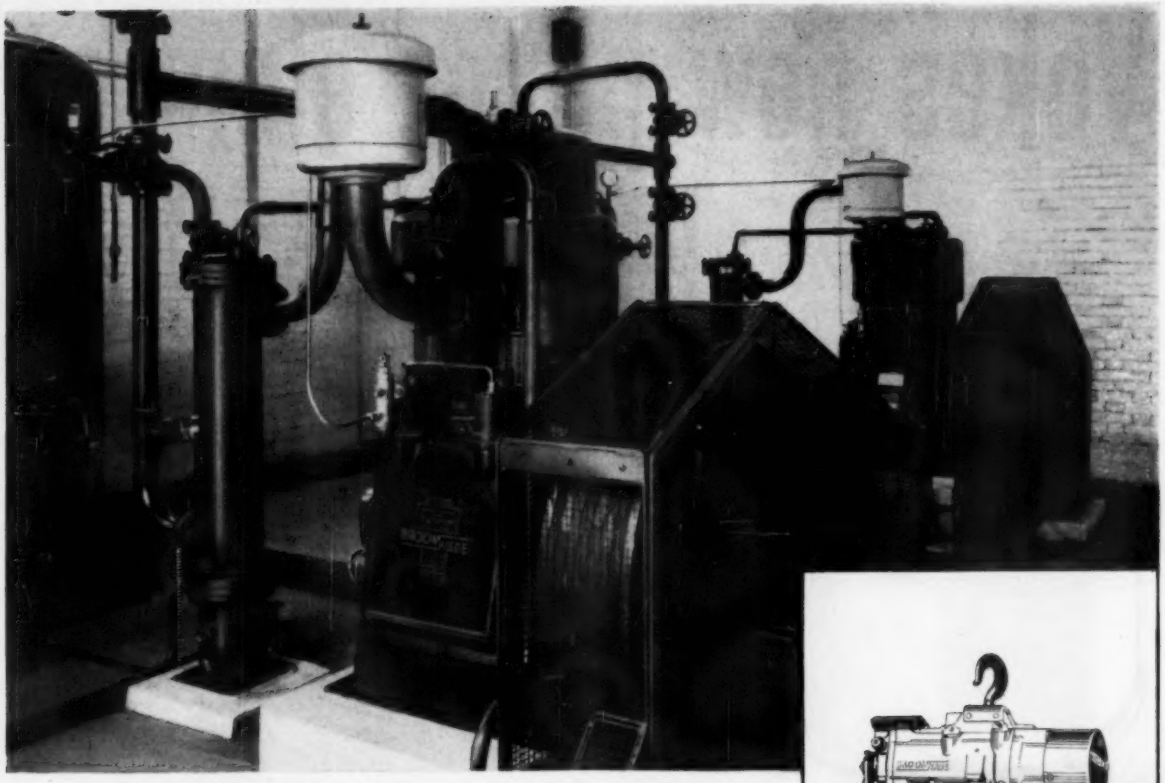

"Broomwade" Type D Compressor in use at Rover Car Works, Solihull. (Photograph by courtesy of The Rover Co. Ltd.)

"BROOMWADE" aids Industry

. . . at the ROVER car works

In car factories compressed air provides a large part of the power used. When the job must be done with speed, efficiency and at minimum cost, most works turn to "BROOMWADE" stationary air compressors.

Simple design, slow speeds and adequate cooling ensure high efficiency. Constant research and development are maintaining the "BROOMWADE" reputation for EFFICIENCY and RELIABILITY throughout the world.

Illustrated is a "BROOMWADE" Compressor, Type D, operating at the Rover Car Works, Solihull. This famous company uses a number of "BROOMWADE" Compressors and a large number of "BROOMWADE" Hoists, as do motor manufacturers all over the world.

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A fight between two mustang stallions was quite a common sight on the American plains where wild horses roamed in their thousands in the late 18th and the 19th century.

Of course, in the 20th century, when engineers want flexibility in the horse-power under their control they instinctively think of the hall-mark "SILENTBLOC" for

FLEXIBLE COUPLINGS, FLEXIBLE BEARINGS & ANTI-VIBRATION MOUNTINGS.

Collected over many years, there is a wealth of technical information at your disposal. When a project is on the drawing-board our technicians can be of most help to you . . .

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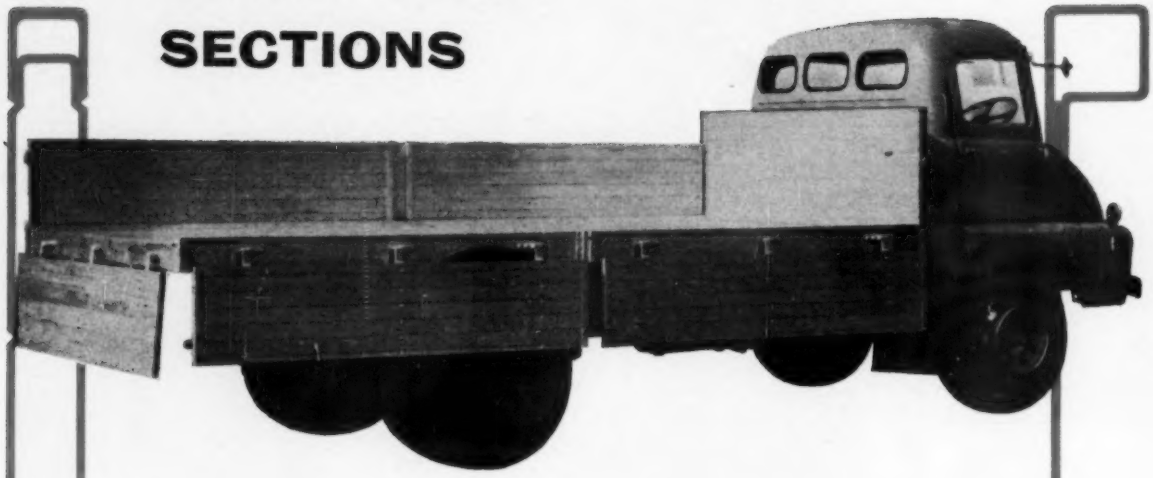
'KYNAL' mark III LORRY BODY SECTIONS



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ALL THESE SPECIAL FEATURES

★ Suitable for almost any type of chassis.

★ Two widths of interchangeable, inter-locking floor sections.

★ Alternative siderails with concealed fixing.

★ Choice of hollow section or sheeted frame dropsides and tailboards.

★ Minimum number of sections required.

★ Greatly improved weight/load ratio.

★ *Floor sections and cross-bearers can be drilled* in position.

★ *Floor fixing bolts readily accessible.*

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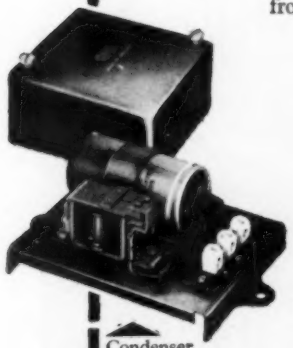
IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.I

ICI METALS DIVISION

KL 12

FLASHERS for SAFETY

Self-cancelling Switch with Warning Light, suitable for flasher operation.

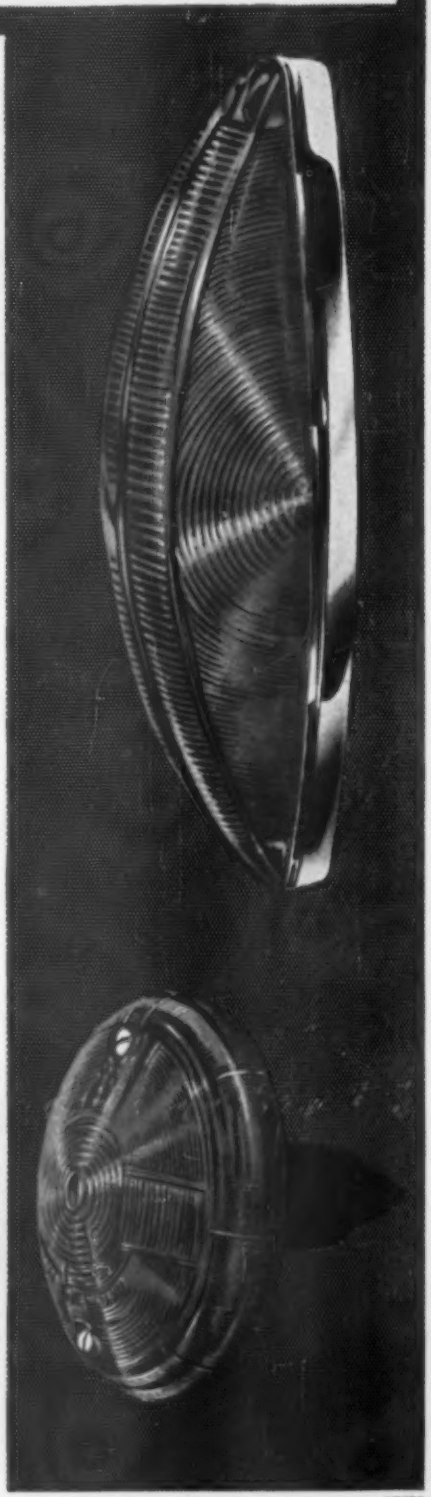


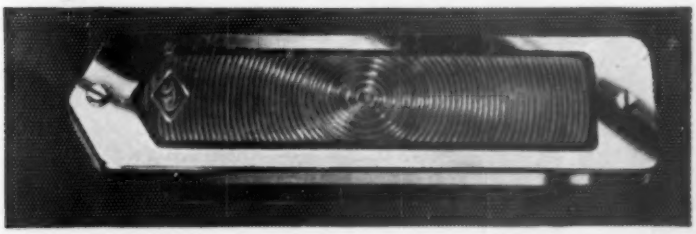
Condenser Relay Flasher Unit with cover removed.

Effective—compel attention in any light

Reliable—only one working part in complete installation

CAV Flashing Indicator Equipment is designed specifically for use on buses, coaches and commercial vehicles up to the heaviest types, whilst sets are also available for tractor/trailer combinations. The lamp units are the result of much development work and their optical design ensures maximum visibility by day or night. Three types are available—circular for front or rear mounting, side mounting and arrow type. The flasher unit is extremely simple, with only one working part, and is therefore reliable; it is also easy to wire and is not vulnerable to accidental damage. Two types of switch are available—the self-cancelling type with incorporated adjustable time delay and indicator light, or a simple hand-cancelling type if required. Full particulars will be sent on request.





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CAV FLASHER INDICATOR EQUIPMENT

The World's Leading Manufacturers of

FUEL INJECTION & ELECTRICAL EQUIPMENT

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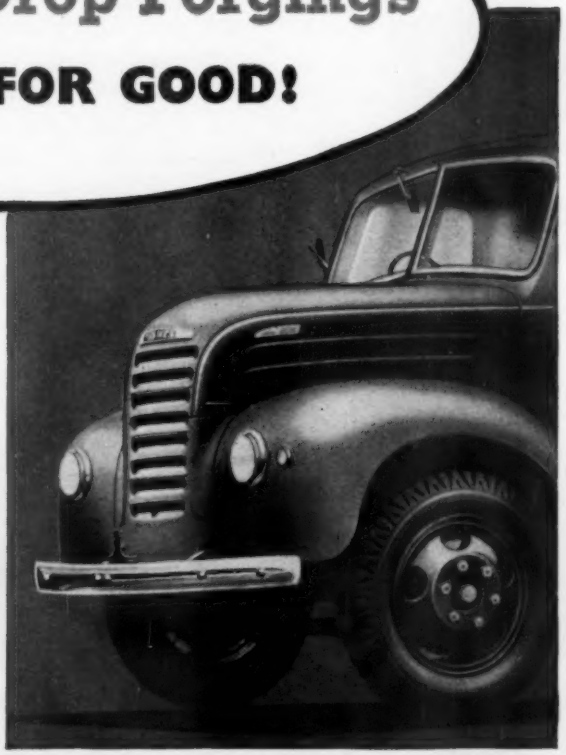
Smethwick Drop Forgings

...FITTED FOR GOOD!



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Slash cutter servicing costs!

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Faster than standard grinders.

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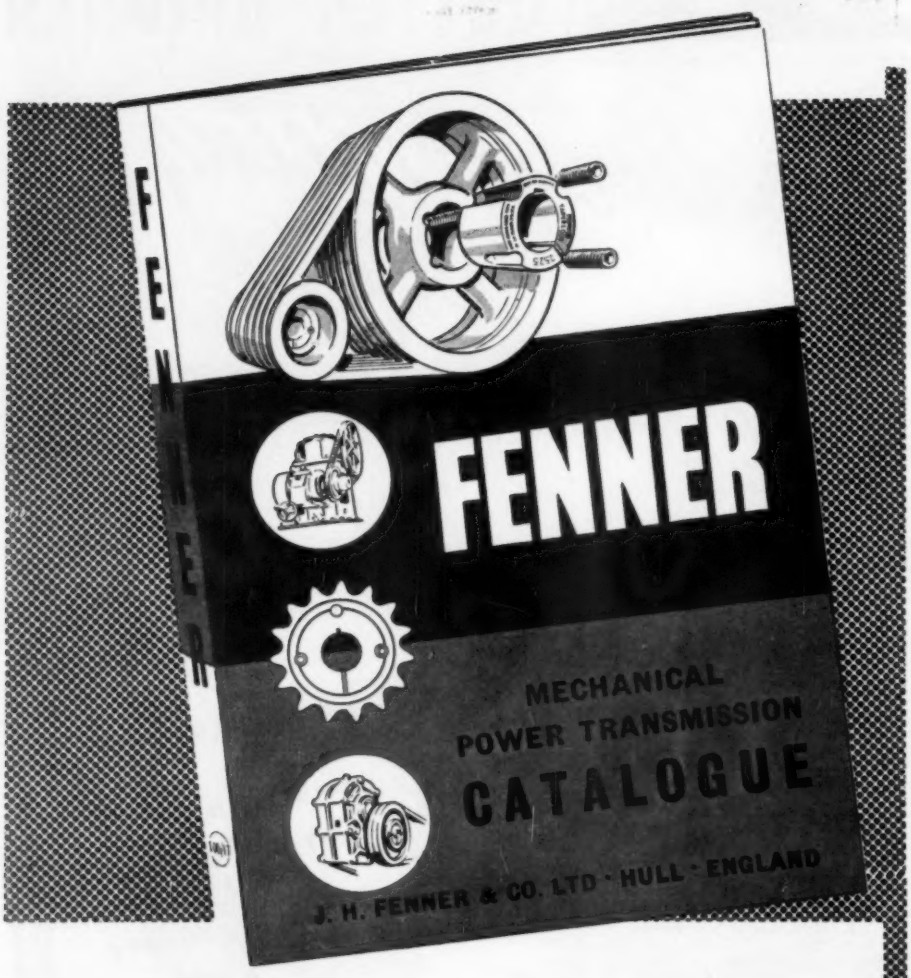
Rainbow 1607

Designing a Drive?



V-BELT DRIVES

V-BELTS

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TAPER-LOCK CHAIN DRIVES

TORQUE ARM SPEED REDUCERS

VARIABLE SPEED DRIVES

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FLAT BELTINGS

PACKINGS AND SEALS

Britain's first pocket size drive handbook, with copious information, convenient to handle and easy to read. Sales 'patter' has been rigorously excluded—this is a working tool for designers and draughtsmen who have already decided to buy Fenner products. It contains just the information the user requires as determined in 25 years experience by the engineering staff of

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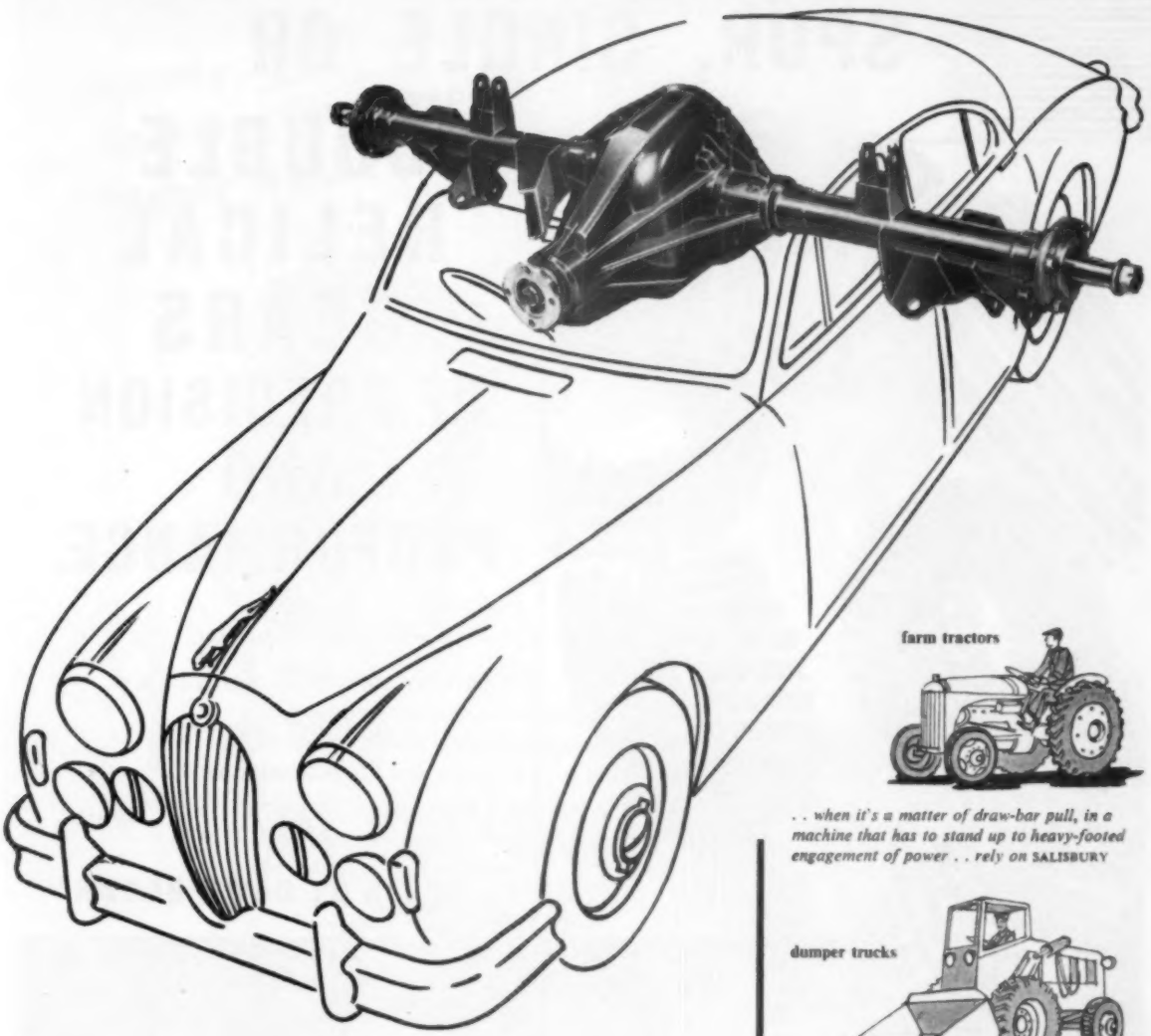
Salisbury Hypoid Axles



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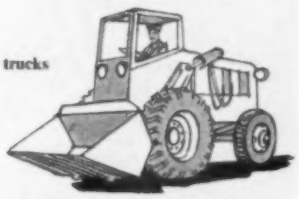

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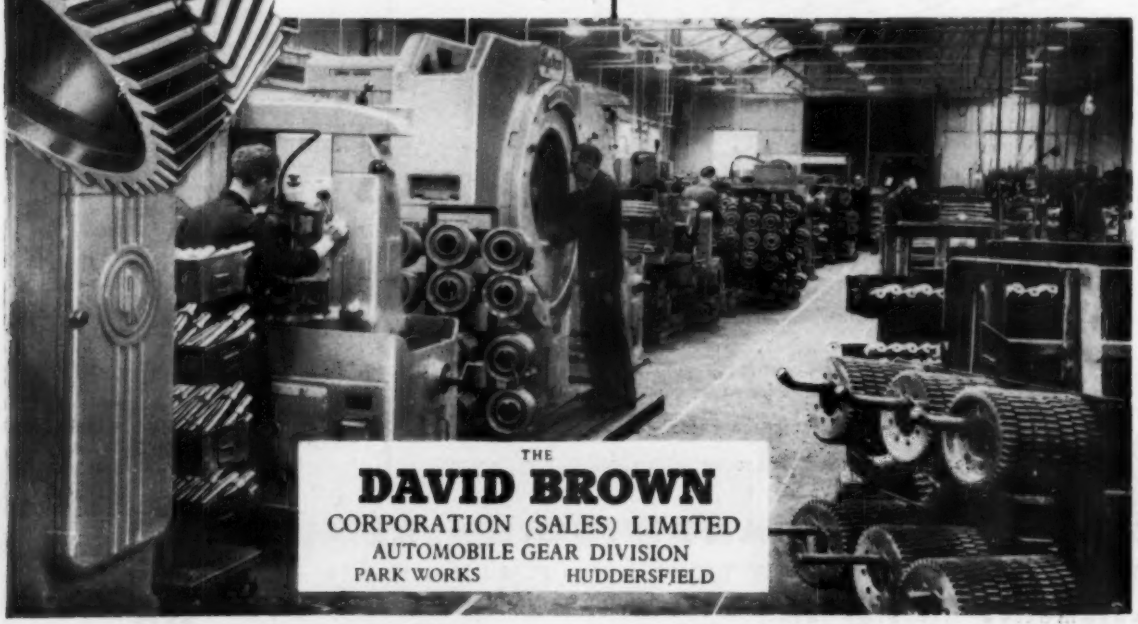

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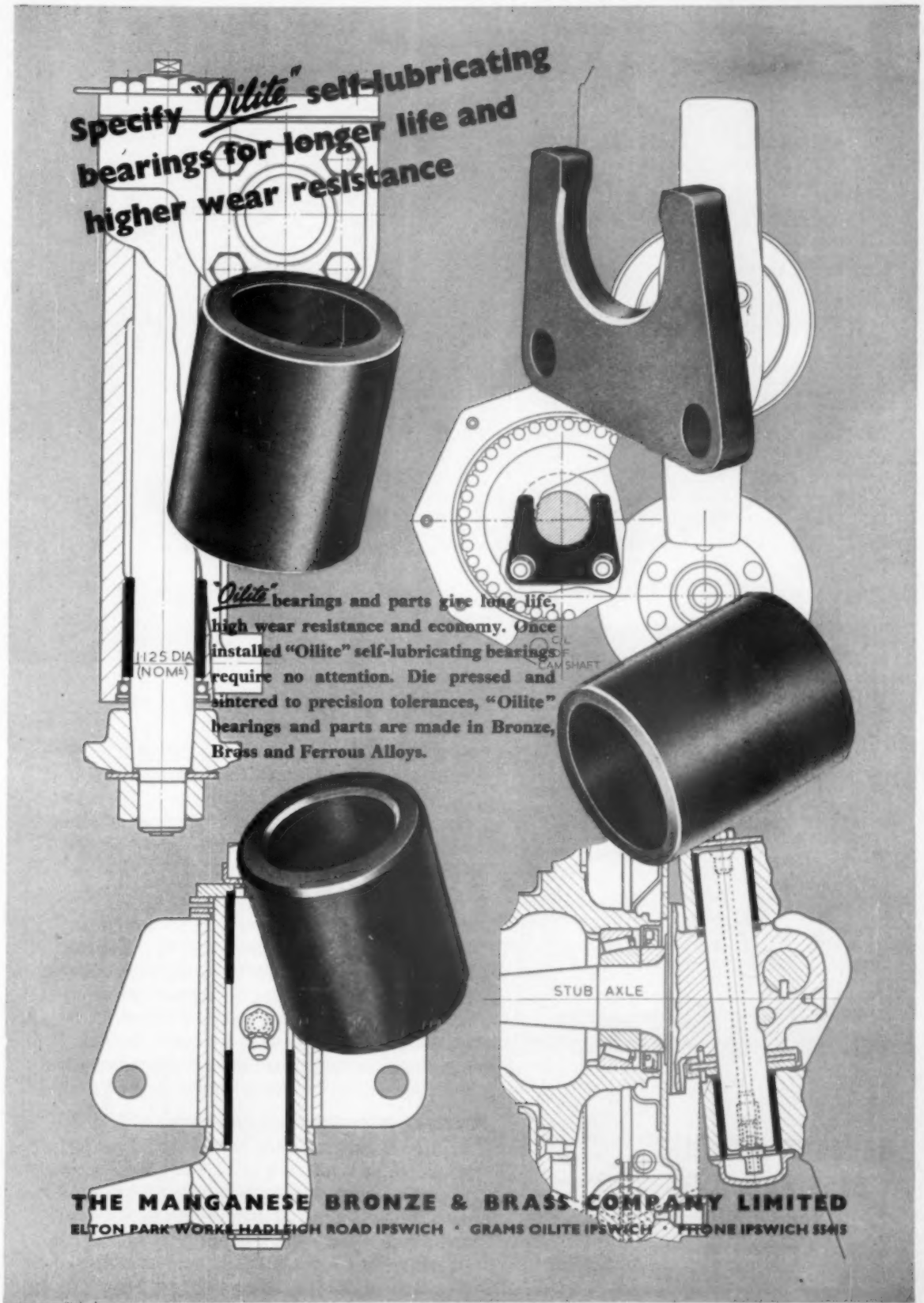
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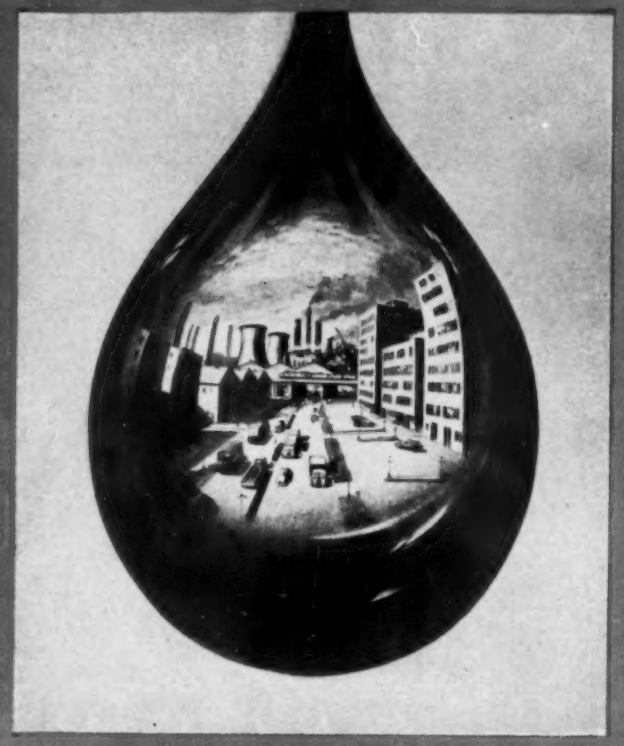

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We do indeed. A bearing's performance is governed by correct lubrication as much as by correct design and materials. The cage location area is one of vital importance. The lubricant must also protect the highly finished surfaces from corrosion and help to dissipate any undue heat. To fulfil these requirements, we have a team of lubrication specialists at work.

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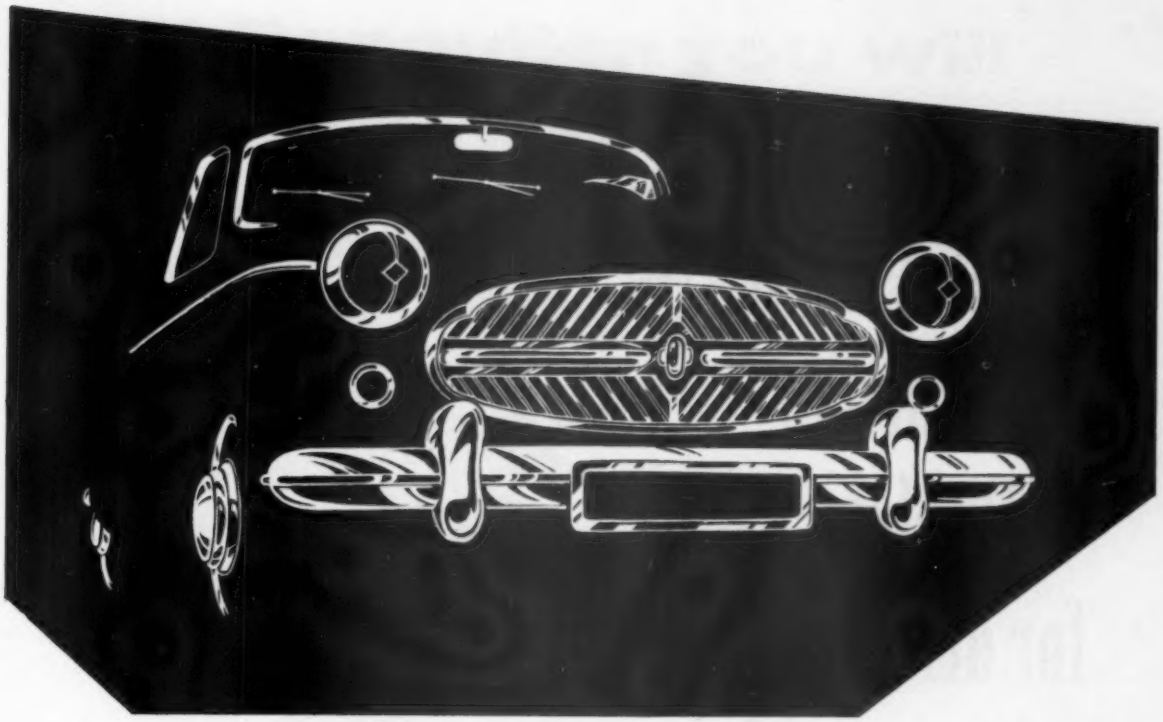

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"The Dewar Challenge Trophy shall be awarded for the year 1957 to the Dunlop Rubber Company, for their outstanding contributions in the field of automobilisation, with particular reference to their work in the development of the Disc Brake, which has contributed to the success of British cars in all fields and the special tyres which enabled the M.G. Car successfully to secure, by a considerable margin, records in International Class F, at Bonneville Flats, U.S.A. in August, 1957".

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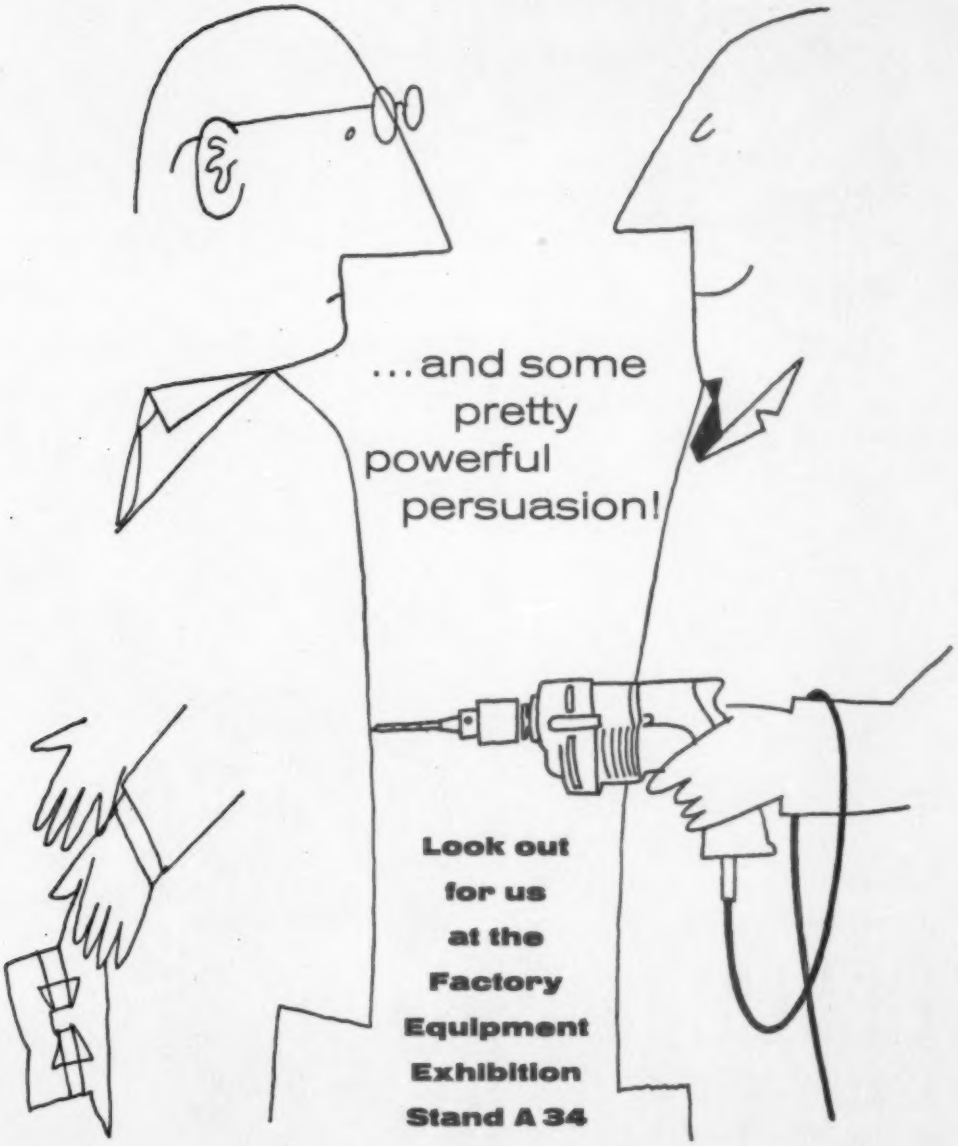

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by

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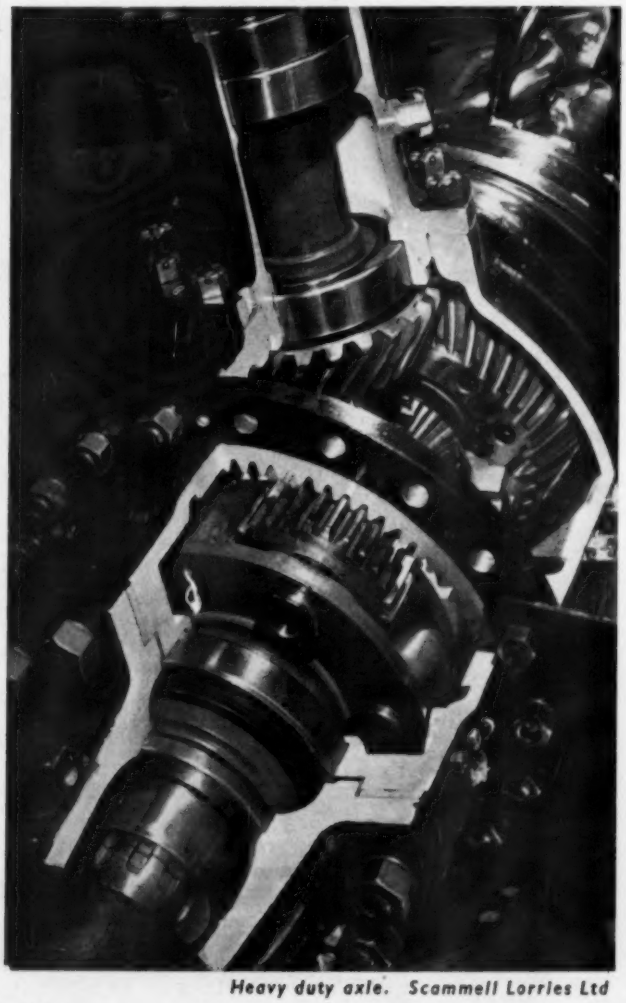

Heavy duty axle. Scammell Lorries Ltd

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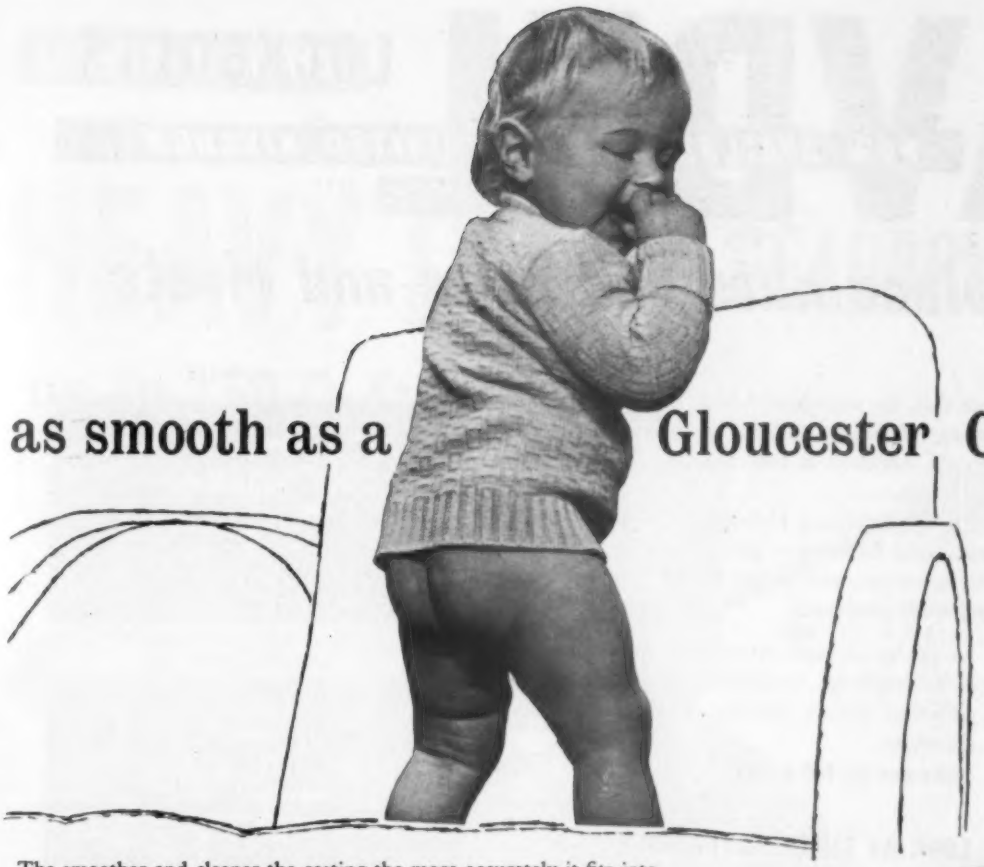

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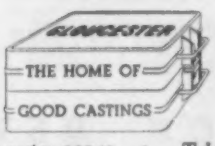

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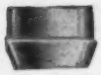

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- ★ Driving is completely automatic—skilled labour not required.
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- ★ High shear and tension strength and high fatigue resistance.
- ★ Automatically placed at uniform pre-tension.
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- ★ High quality work regardless of operators' skill.
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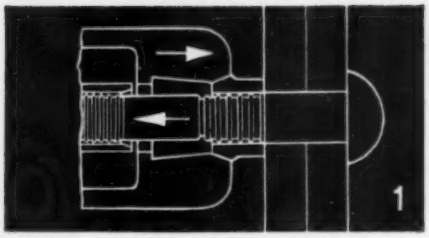
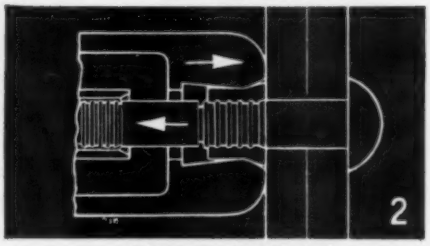
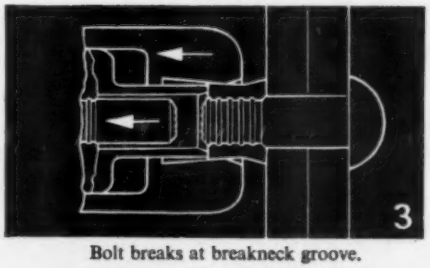


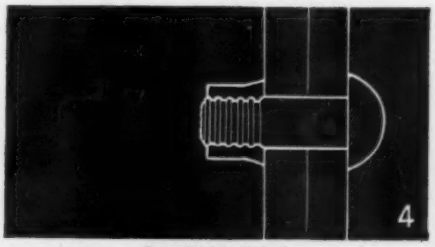
High clenching action clamps sheets together.



Collar swaged and locked into grooves.



Bolt breaks at breakneck groove.



Installed lock bolt.

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REGD. BRITISH PATENTS 629098, 766137, OTHER BRITISH AND FOREIGN PATENTS GRANTED AND PENDING.

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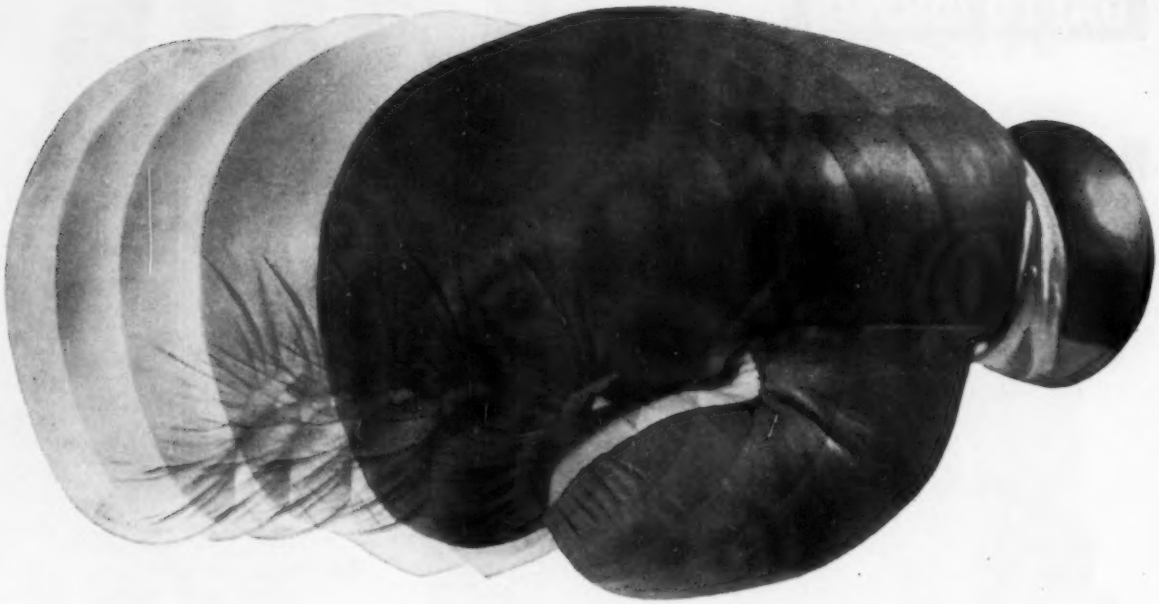

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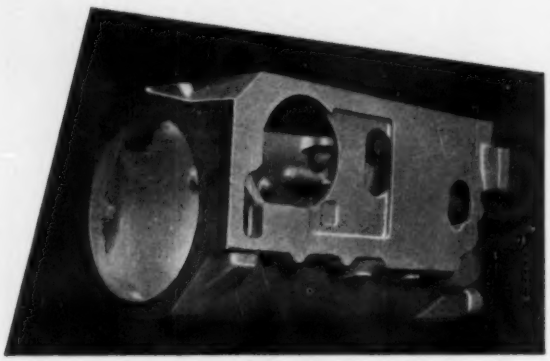

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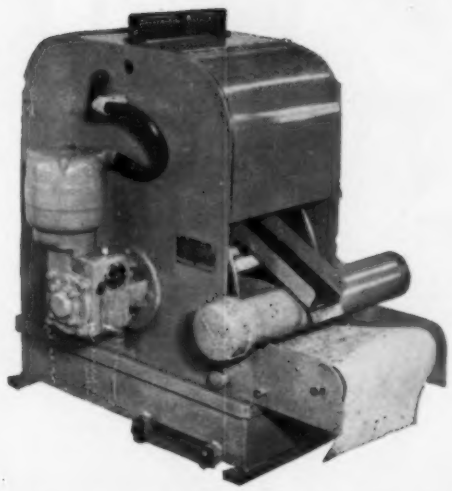

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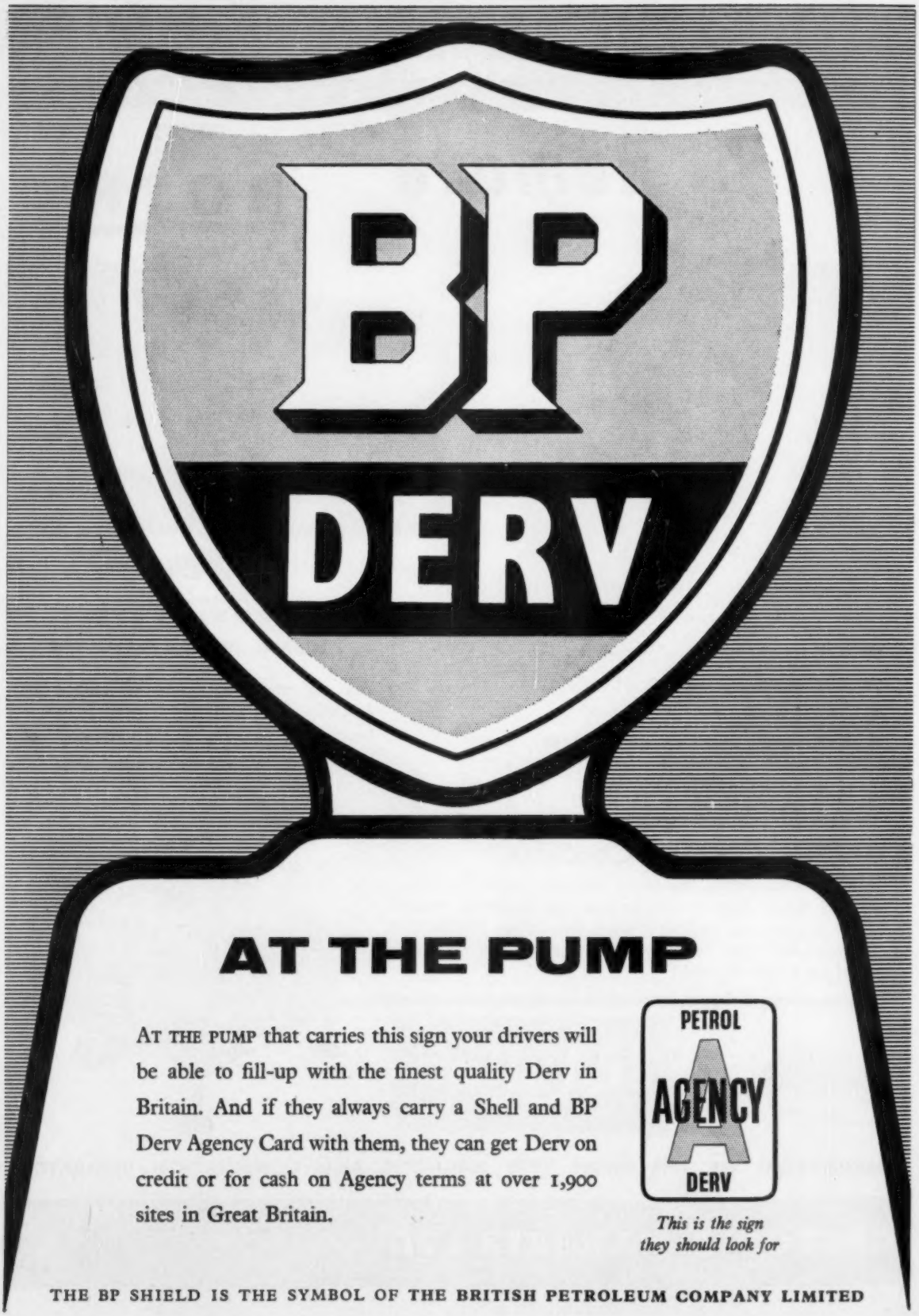

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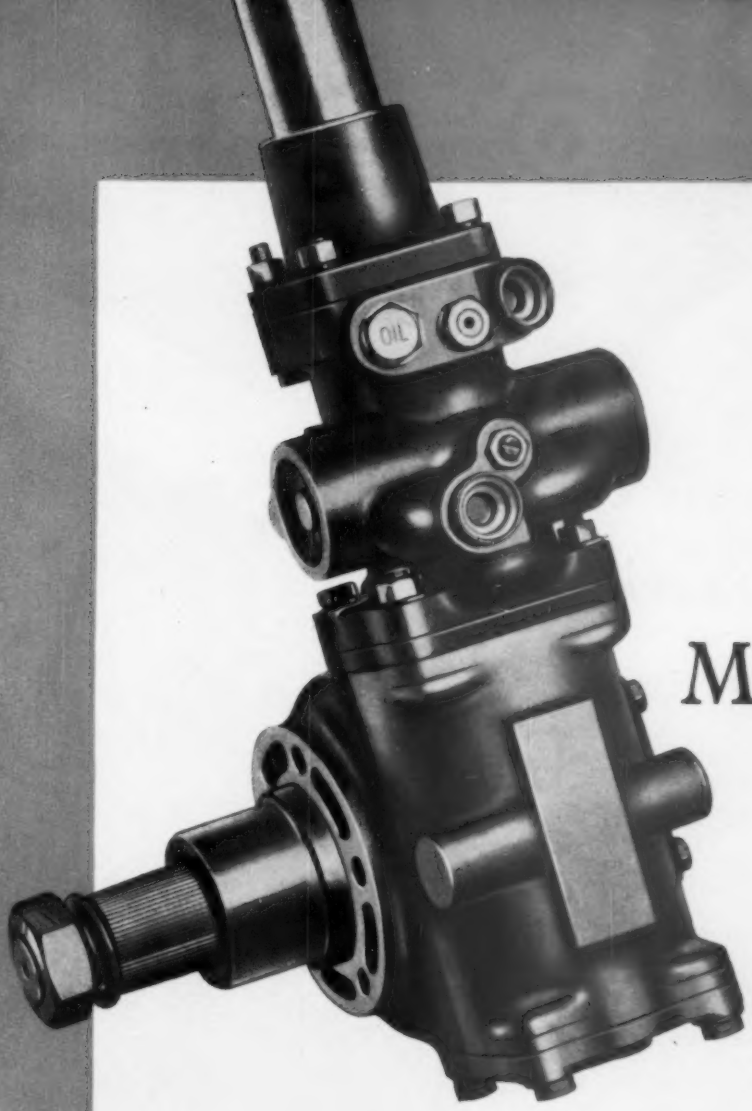

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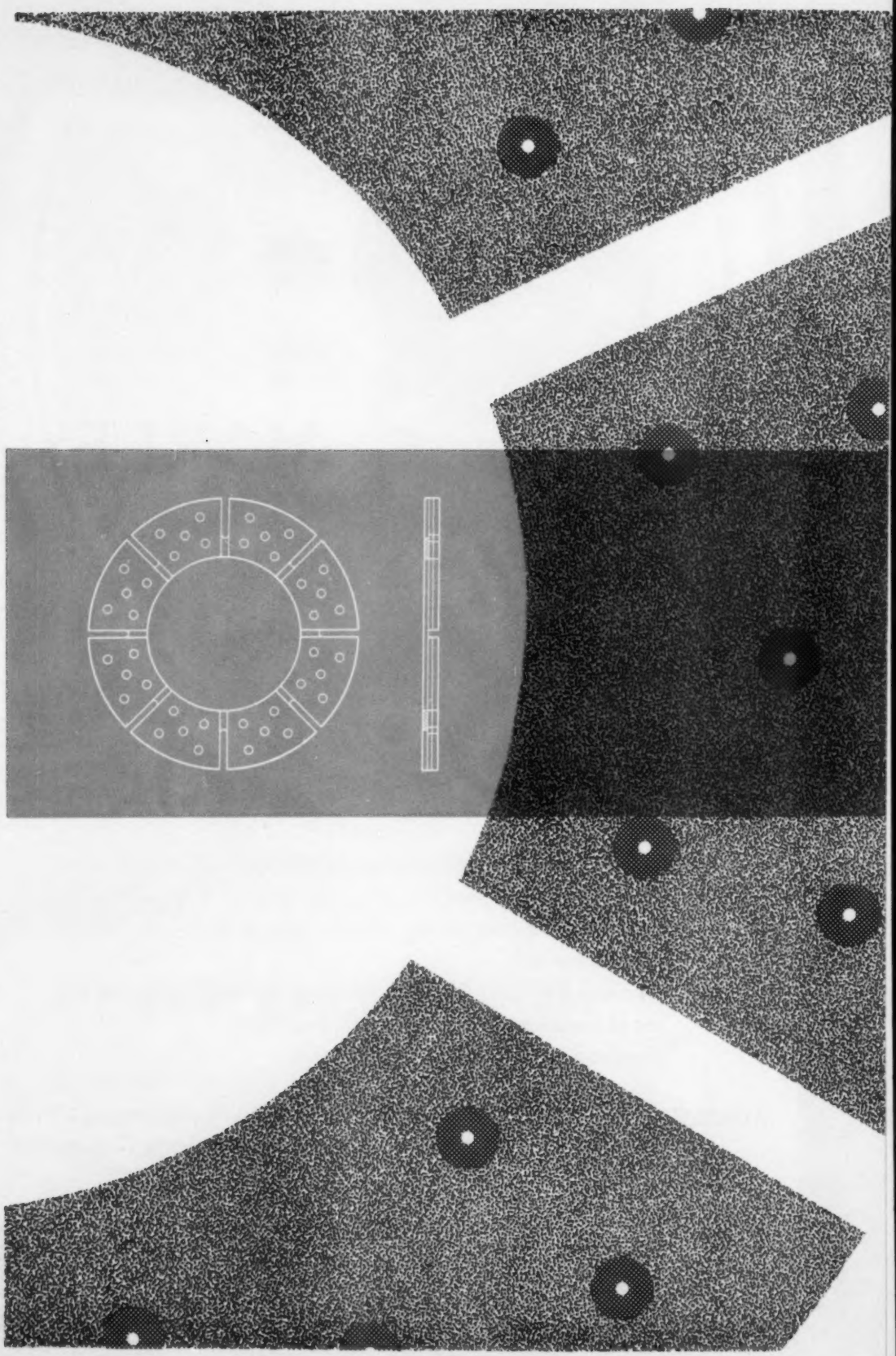

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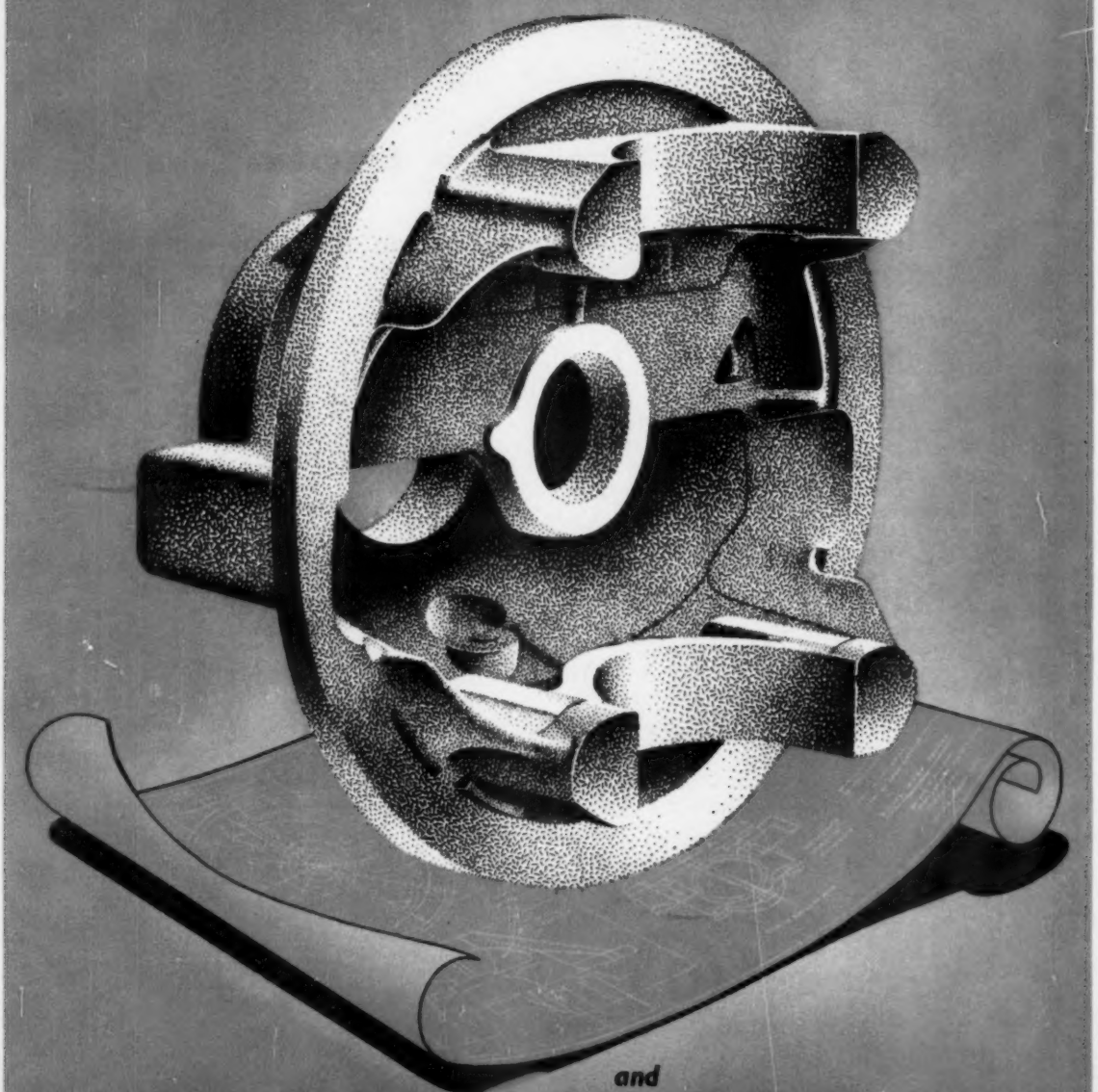

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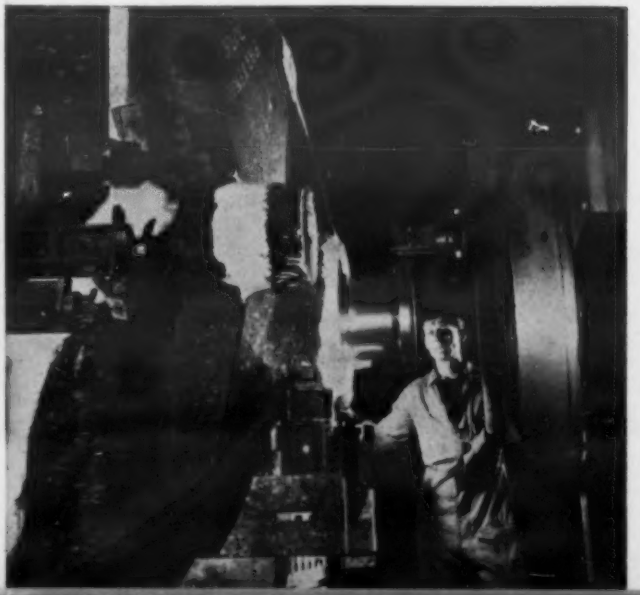

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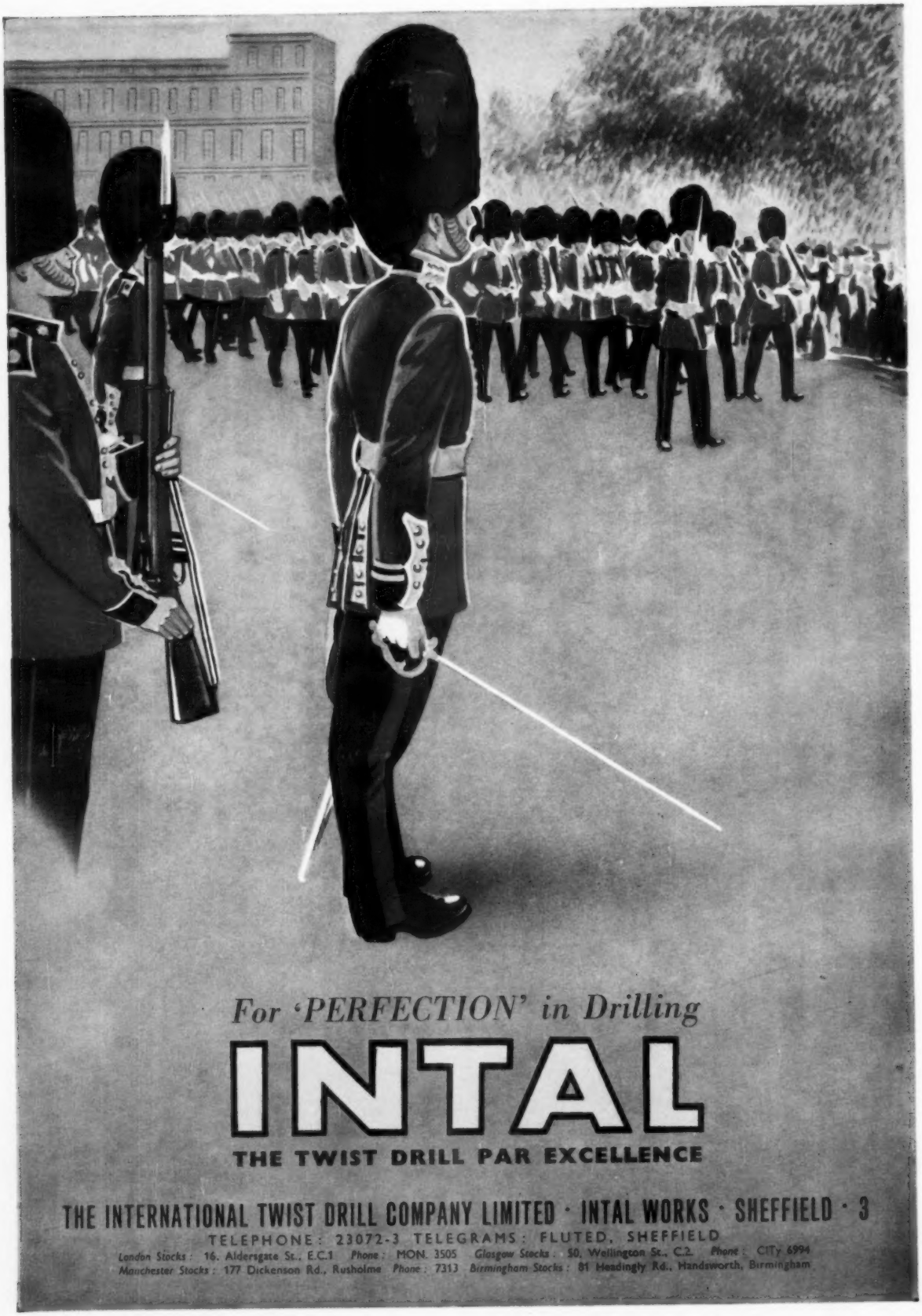
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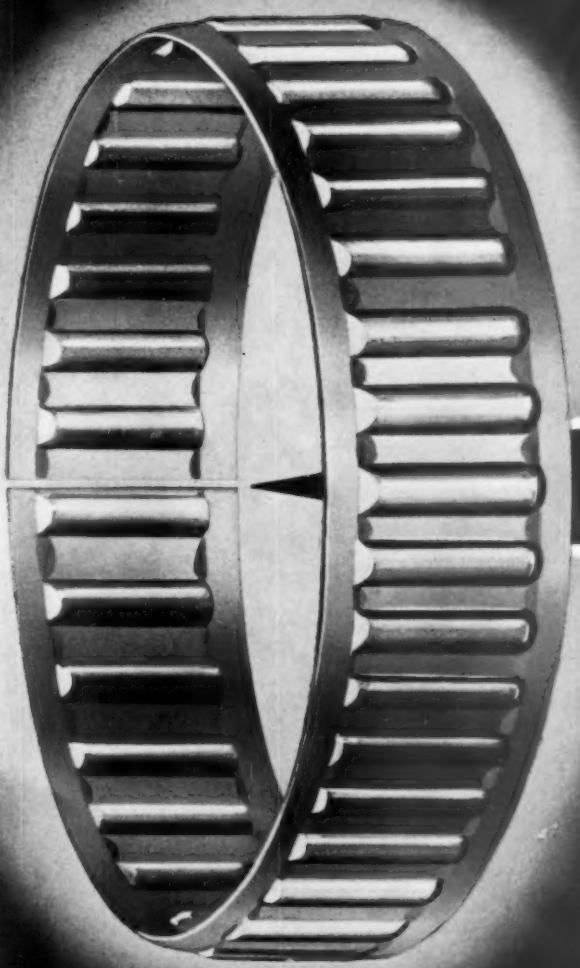

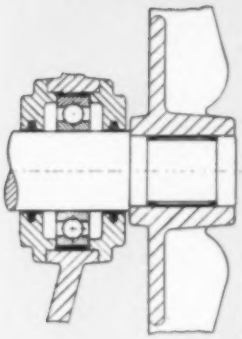

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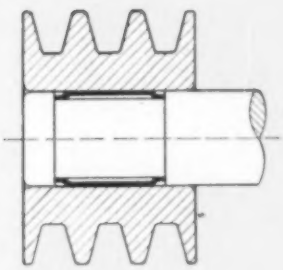

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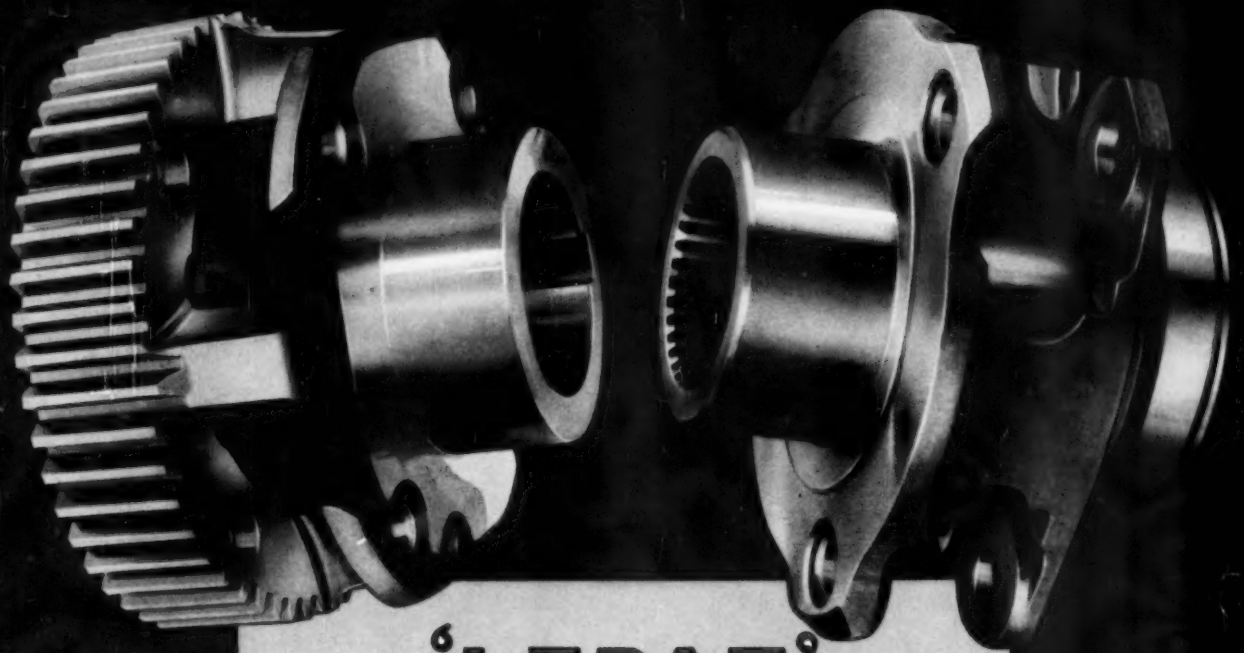

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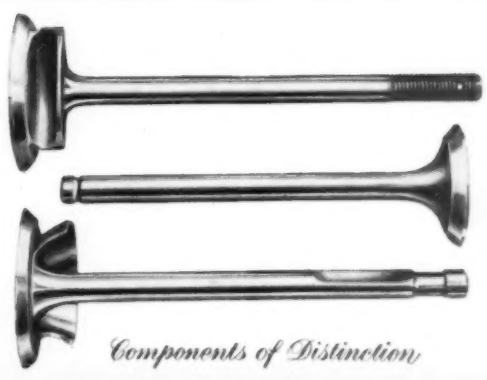

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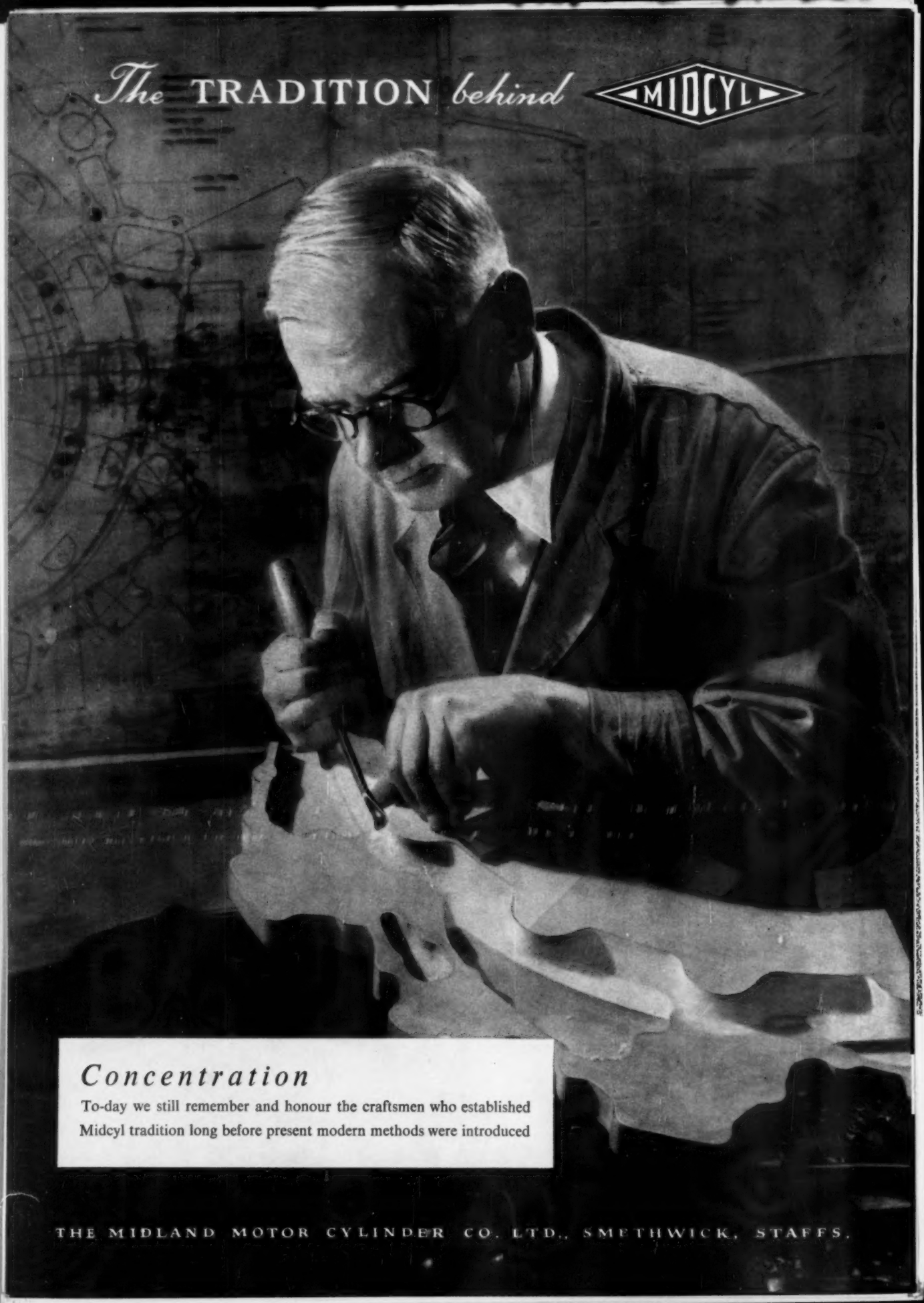
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AUTOMOBILE ENGINEER

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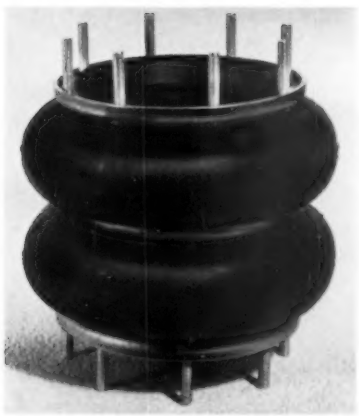

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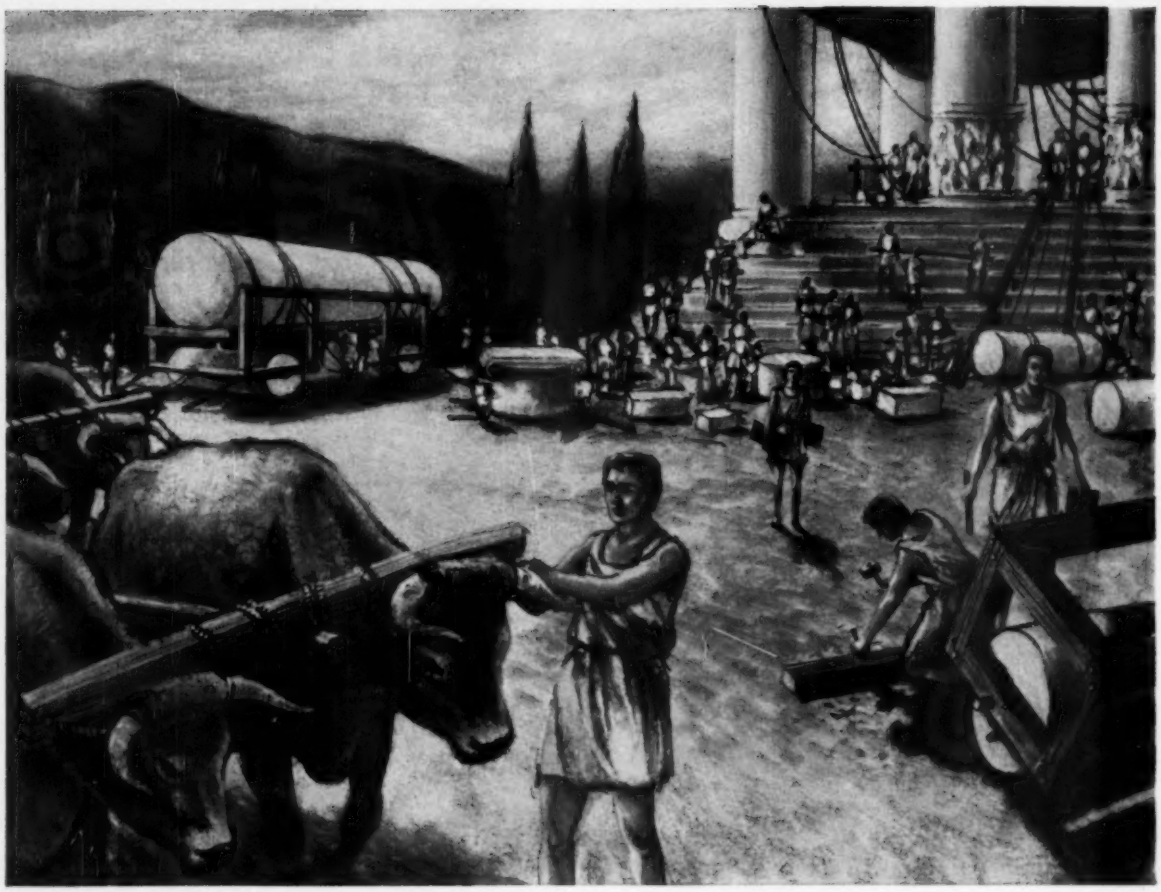

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Engine Development

INCREASED power output without any increase in engine capacity has been one of the outstanding features of the British automobile industry during the past decade. This applies to both compression-ignition and spark-ignition engines, but the remarks that follow mainly concern only the latter type. Of these, it is true to say that current engines give considerably better fuel consumption figures and appreciably greater power output per litre of swept volume than their counterparts of ten years ago. In fact, the high overall efficiency that is now attained does suggest that the time has come to consider on what lines development should proceed.

The actual mechanical efficiency of present-day engines is of an order that rules out any possibility of marked improvement. Even a slight improvement in mechanical efficiency would entail a disproportionate increase in cost. It would, therefore, appear that better engine performance must be sought through other factors. There are only two that offer prospects of success without incurring a relatively large increase in the cost of the power unit—better breathing characteristics and increased compression ratios.

There is no doubt that the better line of approach is through breathing characteristics. This is a subject that in the past few years has received, and is still receiving, a good deal of attention. Developments in this field must, of course, take account of combustion phenomena, about which an increasing fund of knowledge is becoming available. Co-operation between automobile engineers and fuel technologists must result in the development of smoother running engines, in reduced cylinder head deposits and in improved fuel consumption.

Although we can give unqualified approval to development along the lines mentioned in the previous paragraph, we cannot say the same for increasing power output by increasing compression ratios. At the present moment this would, in fact, be a foolish development so far as the British automobile industry is concerned. Vehicles which are being sold in world-wide markets must be suitable for operation on relatively low-grade fuels, and the compression ratios currently adopted by British manufacturers are about as high as they can be to give satisfactory service with such fuel.

Even if fuels of high rating were freely available in all markets, it is still doubtful whether any marked increase in compression ratios would be justified. This may seem to run counter to American practice, where there is a definite trend towards ratios in the order of 10:1. General British practice for standard engines is, of course, to use a ratio of about 7:1, although there are some models with ratios as high as 8:1. The high American ratios were probably adopted as a result of the "horse-power race" that started in the United States some two or three years ago. This call for a tremendous power output was a sales promotion project rather than a logical engineering development, and many automobile engineers in the United States of America were strongly opposed to it.

In general, we consider that the case for an appreciable increase in compression ratios is weak. Any extra efficiency gained in this way would be offset, at least in part, by the consequent heavier loadings on the bearings and the necessity to adopt heavier scantlings throughout the engine.

Nor can it be said that present-day passenger cars are under-engined and need more power. In fact, there are knowledgeable persons who consider that many models have too much power, and therefore too much speed, for their road-holding qualities. This is an arguable point, but there is no doubt many are much too fast for their drivers' capabilities. It is no exaggeration to say that by far the greatest majority of drivers of modern automobiles already have more speed at their command than they can use with safety. Fortunately, most drivers, either from a sense of road courtesy or for the sake of their own skins, seldom attain the speeds of which modern vehicles are capable; so why seek more power merely for the sake of a minority?

These arguments are not advanced to suggest that engine development should stagnate. On the contrary, we think it should certainly continue, but with the emphasis on fuel economy and reliability rather than on still higher power output. We do suggest, however, that the limited resources available for research and development work, both in money and man-power, might with advantage be, in some measure, diverted to other aspects of automobile engineering that have not received the attention, nor reached the efficiency that the power unit has.

THE PANHARD DYNA 55 ENGINE

A Horizontally Opposed, Twin-Cylinder, High-Performance Air-Cooled Unit

THE Panhard Dyna engine is one of the most outstandingly successful small units that has been produced since the war. It was conceived under very difficult conditions during the German occupation, and considerable credit is due to the Company for their having foreseen at that time the general specification necessary to meet the demands of the post-war period. The engine was designed for a range of vehicles intended to meet the requirements of those who are not prepared to accept any sacrifice of comfort, but who expect something better than the conventional family saloon, so far as performance is concerned. To obtain good performance, light weight is, of course, essential. The manufacturers therefore decided to make extensive use of light alloy and to keep the size of the vehicle to a minimum consistent with the provision of adequate room for the driver and passengers. By keeping the weight of the vehicle to a minimum, it was possible to use a small engine, and the horizontally-opposed layout was chosen because it is the most compact, so far as the overall length is concerned. This layout enables a front wheel drive arrangement to be employed without making the bonnet unduly long; also, front wheel drive was considered necessary to avoid the encroachment on the space available for the passengers that would have been inevitable had it been necessary to make provision for the accommodation of a propellor shaft and final drive unit on the back axle.

The first engine produced developed 23 b.h.p., and successive modifications have brought the power up in stages to the present value of 42 b.h.p. At each stage, the engine was thoroughly tested to ensure that the increase in power did not detract from its reliability. All the time, the aim has been at economy in fuel consumption and improvement so far as noise reduction is concerned.

Apart from short length, there are a number of other advantages to the horizontally-opposed, twin-cylinder layout. One is that the reciprocating forces are balanced, although there are unbalance couples due to the 40 mm offset of the cylinder axes. Another is that the two cylinders are cooled equally well, despite the fact that there are no baffles round them and a simple unshrouded fan is employed. By employing a two-cylinder instead of a four-cylinder unit, it has been possible to use pistons and valves of larger dimensions, which are therefore more robust. Further, a specific amount of wear, for example, between the piston and cylinder bore represents a smaller percentage of bore diameter when larger components are employed. Other obvious advantages are economy of production, and simplicity of breathing arrangements.

The air-cooled layout eliminates the radiator, water pump, pipes, hoses and other joints, and water jackets round the cylinder and head. Another advantage is that there is no danger of damage during very cold weather: in some countries this is of prime importance. The weight of the air-cooled unit is less than that of a corresponding water-cooled engine with its radiator and coolant. These advantages have been obtained without incurring many of the disadvantages associated with air-cooled engines. Although the dry sump principle has had to be employed, the oil drains through a 14 mm diameter hole into the oil tank, which is cast integrally with the base of the crankcase. Thus, the need for a scavenge pump is obviated. As has already been mentioned, a simple cooling fan has been employed. This arrangement has been possible because of the high thermal conductivity of the aluminium alloy cylinders. The walls of these cylinders are thick, and the design is such that changes in tappet clearance, due to expansion of the cylinders, are minimised. Cells, formed integrally with the cylinder head, and cast aluminium covers enclose the rockers. All these features have combined to reduce the noise.

A stroke:bore ratio of 0·884 : 1 has been adopted and the connecting rod length : stroke ratio is 1·75 : 1. Thus, the mean piston speed at maximum b.h.p. is only 2,460 ft/min. A high maximum b.m.e.p. has been obtained; it is 137 lb/in^2 at 3,500 r.p.m. The ratio of maximum torque : torque at maximum b.h.p. is 1·09 : 1 and the ratio of engine speed at maximum torque to that at maximum b.h.p. is 0·7 : 1. The specific output figures of the engine are 49·5 b.h.p./litre and 2·38 b.h.p. per square inch piston area. A dry weight of 168·4 lb is quoted, so the b.h.p/lb is 0·25. The overall dimensions of the engine are: height, less air filter, 22½in; width, less air filter, 29⅜in; length, less flywheel, 13in.

Crankcase and cylinders

The crankcase is a simple casting of aluminium alloy. A cell is cored in its base to form the oil reservoir. The front face of the casting is recessed to form half of the timing drive casing, and the remainder of this casing is formed by the pressed steel cover. At the rear, the casting is extended to house the flywheel. Two heavily flanged apertures, one on each side, receive the spigot ends of the cylinder liners. The flanges are 32 mm deep × 93 mm inside diameter and their outer end-faces are machined to form the seats for the flanges round the liners.

To facilitate assembly, tapers are machined for a length of 10 mm on the outer peripheries of the ends of the skirts of the nickel chrome iron cylinder liners. The bores are chamfered at an angle of 30 deg to ensure that the pistons and rings enter readily. Flanges are formed near the inner ends of the 91 mm outside diameter liners. These flanges are 99 mm outside diameter × 2½ mm thick at their outer peripheries, and they are buttressed by a 45 deg fillet.

The cylinder barrels and heads are integral; a shoulder, to seat on the end of the liner, is formed internally at the junction between the head and the barrel. Four 11 mm diameter studs, waisted to 8 mm diameter, are screwed into the crankcase to hold down the cylinder and head casting on the end of the liner. The nuts are tightened down on to lugs, formed on the casting, approximately in line with the outer end of the liner. These lugs are 16 mm deep × 16 mm long. Two of the cooling fins above each lug are machined away locally to accommodate the nuts. The third fin above each lug has a hole drilled in it to give adequate clearance for the end of the stud, which is rounded to facilitate assembly of the nut. A steel plain washer is, of course, interposed between the nut and the aluminium alloy face of the lug.

All the fins are machined and are of plain rectangular, as opposed to tapered, section. They are 2½ mm thick and the space between them is 4½ mm. The thickness of the aluminium barrel is 11½ mm at its inner end and the fin section at

this end is 17½ mm long. At the outer end of the liner, the barrel is 24 mm thick, including the width of the face that seats on the end of the liner, and the fin is 23 mm long.

The method used to hold down the cylinder is good, since it leaves the cylinder barrels free to expand axially. This means that not only is the tension in the holding down bolts almost constant, regardless of the temperature of the engine, but also only the expansion of the cylinder head and liner can affect tappet clearances. Another advantage of the arrangement is that the employment of a cylinder head gasket is avoided; in view of the trouble sometimes experienced due to blowing of the gaskets, this feature will be welcomed by most owners. The absence of obstruction to the flow of heat from the head to the barrel is another good feature of this integral design. Because of the symmetry of the design and lack of constraint on the expansion of the barrel, there should be no trouble with bore distortion.

Crankshaft assembly

The whole crankshaft assembly, including the two main journal bearings, is inserted through an aperture in the rear end of the crankcase. Both main journal bearings are of the roller type. The front one is 85 mm outside diameter × 45 mm inside diameter, while the rear one is 90 mm outside diameter × 50 mm inside diameter. A shouldered housing in the forward end of the crankcase receives the outer race of the front bearing, while the outer race of the rear bearing is carried in a flanged, barrel type housing spigoted into the aperture in the rear wall and secured by twelve 7 mm studs.

The crankshaft is built up from three pieces, the front and rear ends, each complete with one crank pin, and, thirdly, the centre web. Its length between the main journal bearings is 100 mm. Between the centre web and the balance weights, which are bolted to the inner faces of the outer webs, the clearance is 9 mm. The thickness of the centre web is 25 mm and the outer webs are 20 mm thick. Both crank pins are 40 mm diameter. The shaft is drilled 18 mm diameter from end to end, that is, through the centre web as well. It is plugged at its front end by the bolt that retains the timing drive and pulley assembly, and its rear end is sealed by a pressed-in plug. The needle roller bearing for the front end of the clutch shaft is housed in the bore immediately behind the sealing plug and is retained by two snap rings, one at each end. These rings also form oil seals.

Each crank pin is axially drilled 16 mm diameter to reduce its weight and therefore the size of the balance weight that has to be fitted. This hole is increased to 20 mm diameter over a length slightly more than that surrounded by the intermediate crank web. A plug, the length of which is equal to that of the intermediate web, is inserted to prevent radial deflection of the pin under the compression loading due to its interference fit in the hole in the web. This plug is drilled and tapped to receive a 6 mm diameter bolt, the head of which has a tapered seating face and is tightened into a dished pressed steel plug that seals the other end of the hole in the pin.

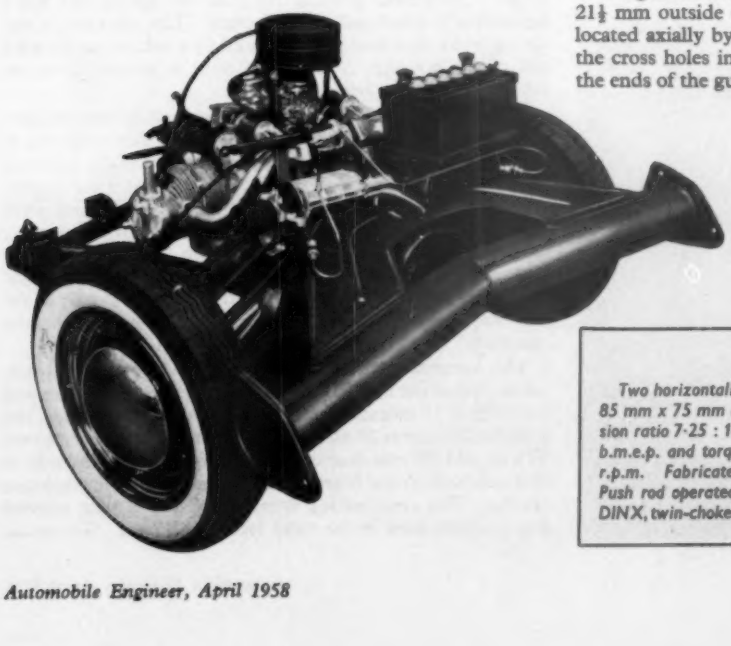
Annular, pressed steel oil traps are spigoted into the end faces of numbers 1 and 3 crank webs to catch oil flung out by the main journal bearings and to feed it into holes in the crank pins and thence out to the big end bearings. A balance weight is spigoted into a 20 mm diameter hole in each end crank web and retained by a set screw assembled from the other end of the hole and screwed into a tapped hole in the weight. A shouldered dowel, in a hole in the crank web, prevents rotation of the weight relative to the web.

Connecting rod and piston assemblies

The NC AV 2 rods are plain, rectangular cross section forgings, but have bosses formed at each end to carry the bearings. Their centre-to-centre length is 131 mm and their minimum cross section dimensions are 25 mm × 62 mm. Double-row roller bearings are employed in the big ends. They are of unusual design in that the rollers in each are alternately big and small in diameter. The large diameter rollers function in the normal manner and carry the bearing loads, while the smaller diameter ones are part of the cage. Thus, as the pin rotates in the bearing, there is no sliding contact between the large diameter rollers and the cage, since the small diameter ones roll between them. This increases the mechanical efficiency of the engine as a whole, but it is mainly intended to reduce wear to a minimum and in this way to avoid noise due to rattling big ends. Since the rollers run directly on the pin and in the one-piece big end, this reduction of wear is highly desirable.

Phosphor bronze bushes, 27·5 mm long, are pressed into the small ends of the rods. A slot is milled radially in each side of the connecting rod boss to break into the housing for the bush, and a hole is drilled diametrically through the bush, so that oil splashed into the upper milled slot can pass into the bearing surface. The rod is milled on two sides, simply to make it impossible to assemble it in such a way that the bearing can be starved of lubricant.

A Ugine 14 NC DG steel gudgeon pin is employed. It is 21½ mm outside diameter × 15 mm inside diameter. It is located axially by wire circlips in the grooves in the ends of the cross holes in the piston bosses. The bearing length of the ends of the gudgeon pin in each cross hole is 24 mm.



For ease of assembly and service, the engine and suspension are mounted on a sub-frame, which is bolted to the front end of the platform type chassis

SPECIFICATION

Two horizontally-opposed cylinders, air-cooled. Bore and stroke 85 mm x 75 mm respectively. Swept volume 851 cm³. Compression ratio 7·25 : 1. Maximum b.h.p. 42 at 5,000 r.p.m. Maximum b.m.e.p. and torque 137 lb/in² and 47 lb-ft respectively at 3,500 r.p.m. Fabricated crankshaft, carried on two roller bearings. Push rod operated, overhead valves. Solex 30 PAAI or Zenith 32 DINX, twin-choke, downdraught carburettor. Mechanical fuel pump.

The pistons are of Hyperal aluminium alloy. They are of the split skirt type, with a T-slot in the base of the scraper ring groove. The crown is domed to give the required compression ratio and there are four arched ribs underneath it to carry the loads to the bosses for the gudgeon pin.

There are three compression rings and one scraper ring above the gudgeon pin and another scraper ring is fitted below it. All three compression rings are of plain rectangular section, except in that their faces are slightly tapered to assist running-in. The top ring is chromium plated and the face width of each is 2½ mm.

The top scraper ring is of unusual form. It comprises three rings, each with a tapered face, assembled in such a way as to scrape the oil off the cylinder wall. The centre ring of these three is slotted to allow the oil removed by the upper two to pass into the groove and thence through radial holes to the interior of the piston. Oil removed by the lower of the three rings of this assembly is scraped into an undercut round the land immediately below it, whence it is drained by radial holes. The oil control ring below the gudgeon pin is of the conventional slotted type. Its oil drainage arrangements are the same as for the upper ring, that is, through radial holes from the base of the groove and from the undercut in the land below it.

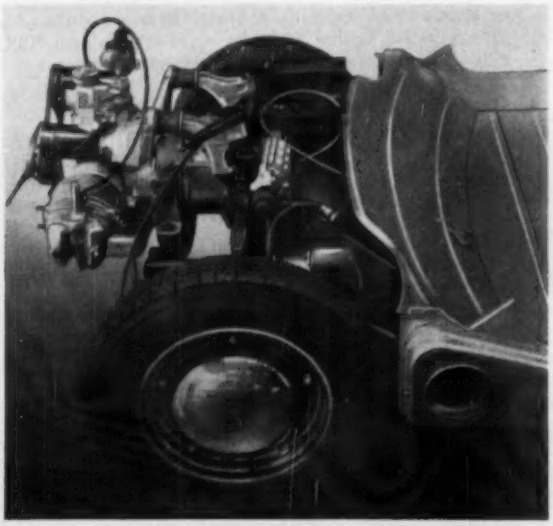
Timing drive and camshaft

The 40 mm diameter front extension of the crankshaft is unusual in that it overhangs the front bearing by a length of only 25 mm and does not extend through the timing drive cover. Instead, the boss of the fan belt pulley is passed through the aperture in the cover, until it abuts against the end of the crankshaft extension, and it is retained by a waisted bolt with a 20 mm diameter threaded end, which is screwed axially into the crankshaft extension. The head of this bolt is circular in shape and has a peg pressed into a hole drilled diametrically through it. The ends of this peg project from the hole to engage the dogs for the starting handle.

To obtain accurate alignment of the pulley and crankshaft extension, the timing drive gear, which is of 14 NC 12 h steel, acts as a muff coupling over these two components. A single, long key transmits the drive to both the gear and pulley. It registers in a groove milled in the front end of the shaft and a slot milled in the rear face of the pulley boss.

A groove is machined round the pulley boss to house a cast iron ring, like a piston ring, which serves as the seal between it and an inwardly-flanged aperture in the front cover, through which the pulley boss is passed. The inner end of this flanged aperture is lipped to prevent oil from draining over it on to the pulley boss. It is shrouded by a cupped pressing clamped between the pulley boss and the timing drive gear. The function of this pressing is to prevent oil being splashed on to the seal housing or the end of the pulley boss; its walls are slightly tapered, so that any oil that might be splashed on it is flung clear of the seal assembly. The main oil thrower is a dished ring interposed between the cupped pressing and the timing drive gear.

With the horizontally-opposed twin-cylinder layout, the engine and gearbox can be readily accommodated in front of the final drive unit



Since the camshaft is below the crankshaft, and therefore this seal is near the top of the timing drive cover, no doubt there is not much oil splashed near it, and this would account for its being adequate. In fact, it is possible that a lip type oil seal in this position would tend to run too dry and fail. The cost of the arrangement is probably less than that of a lip type oil seal and its housing, and presumably its life is longer.

The arrangement of the 34 mm diameter, two-bladed fan is another unconventional feature of this engine. It has a hole punched and flanged in its centre and is spigoted into a counterbore in the front end of the pulley. It is retained by a flanged, cupped pressing held in the counterbore by the bolt that secures the pulley to the end of the crankshaft. The rear face of the flange round this cupped pressing is lined with four pads of friction material, and the fan is forced against it by spring-loaded plungers in holes in the front face of the pulley. This arrangement serves as a damper to eliminate fan vibrations and thus reduce noise.

A Celeron plastics gear, splined and bonded on to a steel hub, is spigoted and bolted to the front end of the camshaft and meshes with the timing drive gear on the crankshaft. The hub has a hole drilled axially through its centre, through which projects a push rod, formed integrally with a piston housed in a 28 mm diameter counterbore in the front end of the camshaft. To retain the push rod in the hole in the gear hub, a circlip is fitted round its forward end, which bears against a spring-loaded plunger.

This plunger is carried in a housing assembly mounted on the pressed steel timing cover. It operates in a flanged sleeve carried in a hole in a dished plate bolted to the rear face of the timing cover. The housing for the spring assembly is mounted on the front face, being spigoted into a hole in the cover and secured by the same three bolts as the flanged sleeve and plate, which are assembled over the inner end of the spigot. A thimble pressing fits over the spring and bears against the forward end of the plunger. The other end of the spring bears on a steel plate, secured by a bolt to the forward end of the housing. An electric cable is connected to the forward end of the bolt.

When the engine is started, the piston and its integral push rod are moved forwards by the oil pressure that builds up in the counterbore in the front end of the camshaft. Contact between the push rod and the plunger completes the electric circuit for the oil pressure warning device. The motion of the spring-loaded plunger is limited by the thimble pressing that is fitted over the spring. Reaction to the oil pressure forces the camshaft in the opposite direction, and rearward movement of the camshaft is limited by the spiral gear of the oil pump drive, which comes up against the rear bearing of the camshaft.

The camshaft is of 14 NC 12 h steel. Its axis is 93½ mm below that of the crankshaft, its overall length is 166 mm and it is drilled 15 mm diameter axially. Between the cams, the outside diameter is 28 mm and the front and rear bearings are 53 mm and 26 mm diameter respectively. At both ends, it bears directly in the bosses in the aluminium alloy crankcase casting. The rear bearing is sealed by a steel plug pressed into a counterbore in the outer face of this boss. The spiral

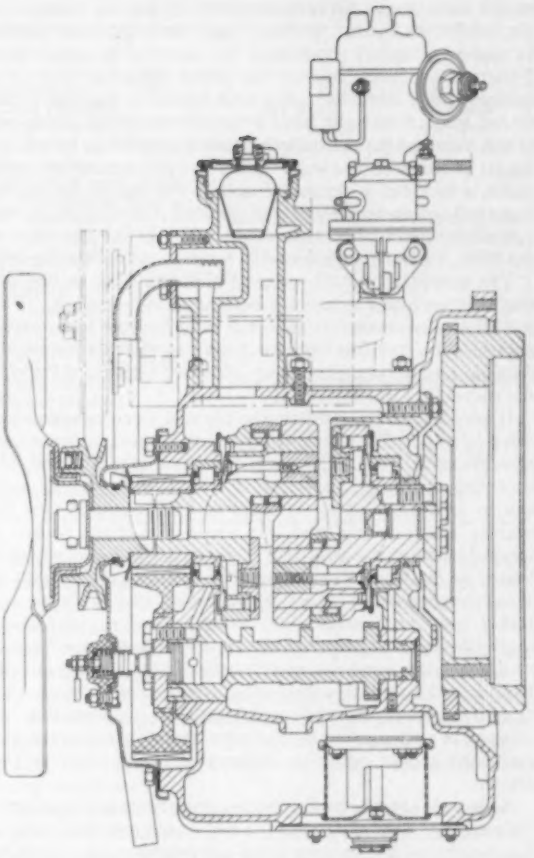
gear for the oil pump drive is immediately in front of this bearing. An unconventional feature of the arrangement is that the distributor is driven by a vertical extension of the oil pump idler gear spindle. A lift of 7·5 mm is obtained at the tappet. Since the rocker ratio is 1·4 : 1, this gives a valve lift of 10·64 mm.

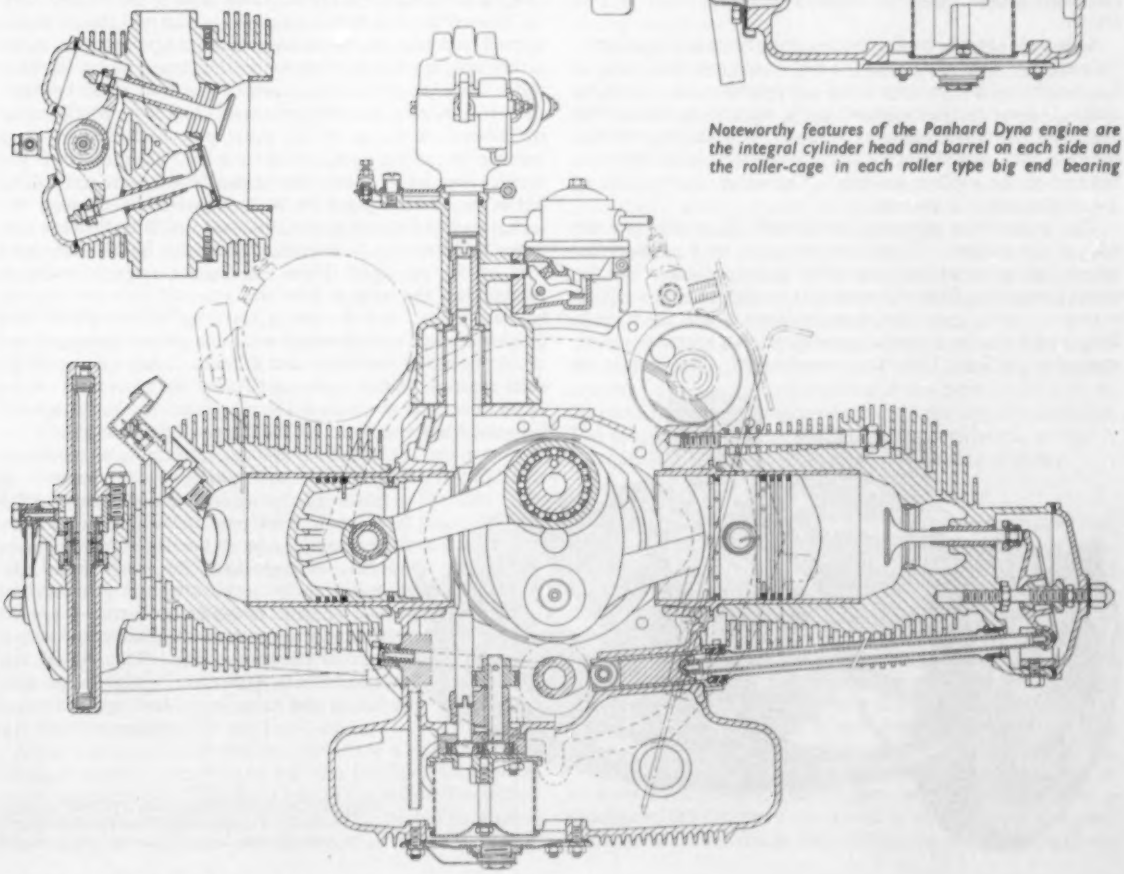
Valve gear

Although the manufacturers have gone to great lengths to reduce to a minimum the weight of the valve gear drive, the tappets are fairly heavy roller type components. They operate in cast iron shouldered guide sleeves housed in bosses in the aluminium alloy crankcase casting. These sleeves, of course, are assembled in pairs; they are located against rotation by flats on each, which register one against the other, and each pair is retained by a set bolt. The lower ends of the sleeves are slotted to form guides for the rollers and their upper ends are counterbored to receive flanged rubber bushes that locate the tubes that house the push rods. Similar rubber bushes are fitted in holes in the rocker box to receive the other ends of the tubes. Annular ribs, or beads, are pressed round the tube to seat on the flanges of these rubber bushes.

The tappets are of AU 4 G aluminium alloy. Their diameter is 18 mm and their overall length is 71 mm. The Ugine 14 NC DG rollers run on hollow pins in their forked lower ends. At their outer ends, the tappets are cupped to receive the spherical ends of the push rods.

Each push rod is 9½ mm outside diameter × 6 mm inside diameter, aluminium alloy tube and has hardened steel spherical fittings pressed in to each end. The fitting at the upper end is carried in a seating machined in one end of the cast iron rocker, and the other end of the rocker bears directly





Noteworthy features of the Panhard Dyna engine are the integral cylinder head and barrel on each side and the roller-cage in each roller type big end bearing

on the valve stem. An unusual feature is that the rockers are not carried on shafts. Instead, each has a spherical seating formed in a cupped recess near the centre of its upper face. This seating bears against the lower spherical end of a retainer sleeve screwed on to a stud carried in the base of the rocker box. A hexagon head is formed round the upper end of this sleeve so that the tappet clearance can be set by adjusting its position on the stud. After the adjustment has been made, a lock nut is tightened against the end of the sleeve. A domed nut on an extension of the stud is used to secure the cast aluminium rocker cover of the box. In the joint face of the cover, a groove is machined to receive a rubber sealing ring.

The advantages of this method of pivoting the rockers are that it is inexpensive and the bearing is self-aligning. This self-alignment feature is good not only because it simplifies manufacture, but also because it ensures that the maximum possible area of contact is always obtained between the end of the rocker and the valve stem.

It is of interest to compare the number of components per valve in this rocker assembly with that in more conventional arrangements. The Panhard system has one rocker arm; one spherical ended bearing sleeve; one stud; and two lock nuts, one to lock the stud to the head and the other to lock the bearing sleeve to the stud; the lower end of the rocker is located between the arms of a U-shape guide-piece, which is bolted to the base of the rocker box. This makes a total of seven components. More conventional systems have one rocker arm; one rocker shaft which, of course, is usually shared between at least two valves; one pedestal; one bearing cap; two studs; two nuts; one tappet adjusting screw; and one lock nut. This makes a total of ten components. An alternative arrangement of the rocker pivots, incorporating an alternative arrangement of the rocker pivots, incorporating an automatic tappet adjuster, is described at the end of this article.

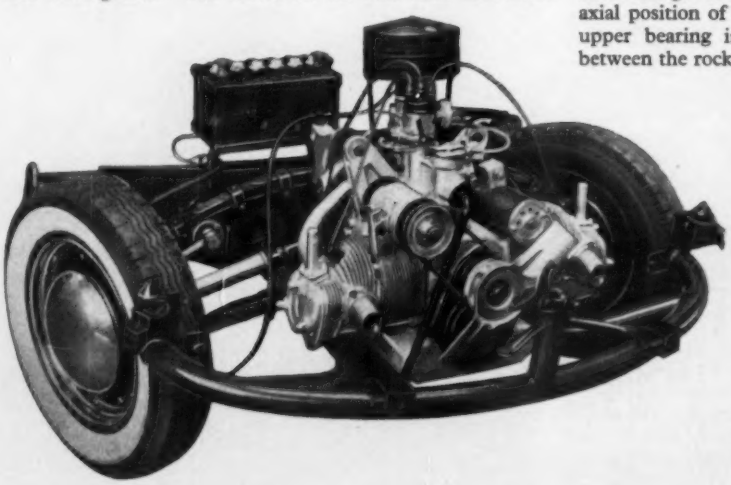
As is well known, torsion bar valve-springs are employed. This arrangement eliminates the coil spring and thus reduces the weight of the reciprocating components of the valve train. It also reduces the length of the valve stem, enables the overall width of the engine to be kept to a minimum, and the spring is well cooled since a large proportion of its length is exposed to the cooling air flow. The main disadvantage of the arrangement is its cost.

The rocker box comprises two small chambers, one for each of the rockers. These are connected by a passage that houses the centre of the torsion bar spring assembly and the levers that extend from this assembly to seat the valves. This passage is arched, and the space between it and the head is finned with a view to obtaining even cooling round the ports and valve guides. The valves are set with their axes at an included angle of 35½ deg in a horizontal plane and the torsion bar spring assembly is between them, with its axis vertical. Although the spring assembly is complex by comparison with the more conventional coil spring arrangement, this is to a certain extent offset by the fact that the one assembly actuates two valves.

Each KN-Ugine 30 NC steel spring is in three pieces. One is a central torsion bar, which is 6 mm diameter × 240 mm between the 10 mm diameter shoulders of its splined ends. The other two pieces are 10 mm inside diameter × 12 mm outside diameter torque tubes which are assembled over the torsion bar from each end and totally enclose it. These tubes are splined internally at their outer ends, where they fit over the splines on the ends of the torsion bar; and they are splined externally at their adjacent inner ends, on which are mounted the lever arms that seat the valves. The outside diameter of the outer ends of these tubes is increased to 15 mm round the splined portion of the bore, and the outside diameter of their inner ends is 16 mm. These tubes are approximately 90 mm long between their thickened ends.

The bosses of the valve seating levers are, of course, internally splined and their outer peripheries are shouldered and ground to form the inner races of the needle roller bearings in which they oscillate. A 26 mm inside diameter outer race is employed for each bearing, and the rollers are 2 mm diameter × 5½ mm long. The outer race for the lower bearing is a simple steel cup, the rollers being prevented from falling out by the base of the cup. The shoulder round the boss of the lever closes the upper end of the bearing. The outer race for the upper bearing is a sleeve, the top end of which is flanged. Its rollers are prevented from falling out at the bottom by the shoulder on the boss of the lever, and from jumping out at the top by a collar formed in the bore of the sleeve. Two flanged thimbles, one over each end, enclose the torsion bars. On assembly, the lower thimble is inserted from above through a hole in the lower face of the central portion of the rocker box, until it is stopped by the flange round its open end. Then the lower lever, complete with its roller bearings and outer race, is assembled through the rocker box opening and placed on top of it, the outer race being housed in a counterbore at the upper end of the hole through which the thimble extends. Next, the upper lever, with the rollers buried in grease round its boss, is passed in through the rocker box and placed in position, and the flanged sleeve that forms the outer race is assembled through a hole in the upper wall of the passage. Then the flanged upper thimble is passed over the torsion bars and spigoted into the bearing housing sleeve, and the whole assembly is retained by two dome-nuts on 8 mm diameter studs that project through holes in the flanges of the sleeve and thimble. Adjustment of the axial position of the sleeve that forms the outer race of the upper bearing is effected by means of shims interposed between the rocker box and the flange of the thimble.

Before the upper thimble is placed in position, the torsion bar assembly is threaded through the splined bosses of the levers and the pre-load of the spring set—the arrangement is such that when one valve is depressed, the other forms the reaction stop at the other end of the spring. Adjustment is made by fitting a special spanner on to an extension on the upper end of the torsion bar. The end of this extension is splined and has a flat on it to locate the spanner. The upper torsion tube is lifted out of engagement with the



Since one-piece aluminium alloy cylinder castings are employed, a simple two-bladed fan is adequate to meet all the engine cooling requirements

splines on the upper end of the bar, which is then twisted by means of a spanner until the appropriate alignment is obtained between the splines on the bar and those on the torsion tube. Then the tube is dropped into engagement and the cover placed in position to prevent it from sliding out of engagement again.

The outer ends of the levers are forked and bear under collars round the ends of the valve stems. These collars have tapered bores and are retained by split tapered collets, which register in a single groove round each valve stem. The ends of each pair of collets abut so that there is a clearance between their bores and the base of the groove round the valve stem: this allows valve rotation to take place. A wire circlip is fitted in a groove in the upper end of the tapered bore of the collar to prevent the collets from falling out in the event of spring breakage; this, of course, avoids damage to the engine as a result of the valve slipping into the cylinder.

Details of the valves are given in the accompanying table. They are of austenitic steel and the ends of their stems are nitrided. Flat heads are employed to ensure that there is adequate metal through which heat can flow freely away from the seats. The extra flexibility that could be obtained by employing tulip type valves is not needed in this engine because distortion is unlikely to occur. This is because the metal round the seat inserts in the head is both thick in section and symmetrical in shape. The valve guides are not interchangeable since that for the inlet valve is 44 mm long while that for the exhaust is 47 mm long. Both are located positively by wire circlips round their upper ends and their lower ends are tapered to reduce the obstruction to gas flow.

The inner end of the exhaust valve guide extends only about 8 mm beyond the end of its housing, so there is an adequate heat flow path. In the inlet port, where gas flow, rather than heat dissipation, is the criterion, the boss that forms the guide housing terminates 12 mm from the end of the guide. Bronze inlet and steel exhaust seat inserts are fitted in the head, which is heated to a temperature of 200 deg C before they are inserted. Two grooves are machined round the periphery of each seating ring to form a key to retain it firmly in position. Both ends of the bores of the seating rings are tapered. The taper at the inner end is, of course, the seating face, while that at the outer end is incorporated to form the valve throat venturi. Both seating faces are cut at an included angle of 120 deg. The included angle of the chamfer at the other end of the seating ring of the inlet valve is 30 deg, while that of the exhaust valve seat is 56 deg.

VALVE DATA

	Inlet	Exhaust
Material	Austenitic steel	
Head diameter	43·5 mm	41·5 mm
Stem diameter	7·97 mm	8·47 mm
Diametral clearance in guide	0·01-0·04 mm	0·02-0·05 mm
Seat angle	90 deg	
Maximum and minimum diameters of face:		
On valve	39·5 and 43·5 mm	38 and 41·5 mm
On seat	39·5 and 44·5 mm	38 and 42·5 mm
Seat material	NCS Bronze	X20T Steel
Springs	Torsion bar	
Valve lift	10·64 mm	
Rocker ratio	30 : 41·2	
Valve guide material	Bronze	
Valve guide length	40 mm	44 mm
Valve guide inside and outside diameters	8 and 13·05 mm	8·5 and 13·05 mm
Tappet clearance	0·10-0·15 mm	
Valve opens	26-29 deg B.T.D.C.	57-60 deg B.B.D.C.
Valve closes	57-60 deg A.B.D.C.	25-29 deg A.T.D.C.
Ignition timing	T.D.C., fully retarded	

Distributor drive

As has already been mentioned, the spindle that drives the distributor is connected to that of the idler gear in the oil pump. It is waisted, from 12 mm diameter at its ends, to 6 mm diameter for a length of approximately 90 mm. Not only does this give the drive a certain amount of flexibility, to absorb shocks, but also it enables it to clear the inner end of the adjacent cylinder liner. The lower end of the spindle is slotted to receive a tongue on the upper end of the idler gear spindle and is spigoted into the top of the oil pump casing. Its upper end is ground down to 10 mm diameter and projects into a sleeve. This sleeve is carried in an aluminium turret casting, mounted on top of the crankcase. The lower end of the sleeve is shouldered to 28 mm outside diameter × 25 mm inside diameter and extends down round the spindle in a cylindrical housing cored inside the turret. There are ports in the walls of the cylindrical housing and in the sleeve, so that the crankcase can breath into an annular space cored round the housing.

A cored duct connects this annular space with a cell in the forward extension of the casting, the oil filler tube being cored just behind it. The front end of the cell is closed by a bolted-on plate, which has a breather pipe passed through a hole in its centre and welded in position. This pipe extends down to a point just below the level of the sump. In the cell, the end of the pipe is closed by a brazed-on disc, and three slots, each 1 mm wide, are machined in the upper portion of the periphery of the pipe.

Since the sleeve rotates with the spindle, breathing can occur only when the holes in its walls are in line with those in its housing. The spindle runs at engine speed, and the timing is as follows: the ports open at 26-29 deg B.B.D.C. and close at 57-60 deg A.B.D.C. This device is necessary, of course, because both pistons approach the inner and outer dead centres simultaneously.

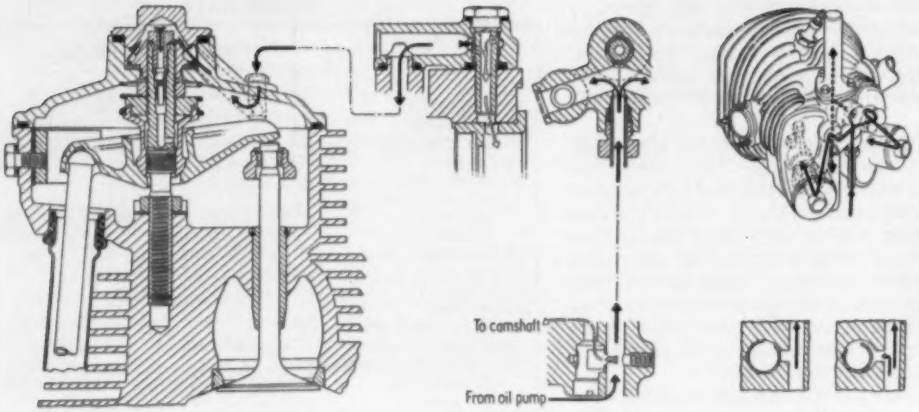
The upper end of the sleeve is 20 mm outside diameter × 10 mm inside diameter. It has a spiral groove machined in it; the cross section of this groove is of a right-angled triangle, the right angle being between the lower edge of the groove and the bore of the housing. The spiral is cut in a direction such that it tends to carry oil up the bore. Thus, not only is the bearing area between the sleeve and the bore adequately lubricated but oil is carried up to the eccentric that is ground near its upper end to actuate the push rod for the mechanical fuel pump. This pump is bolted to the side of the turret casting. An 8 mm thick block of heat-insulating material is interposed between the pump and the casting, to help to avoid vapour lock due to over-heating of the pump.

A contact breaker and distributor unit is mounted on top of the turret casting. The lower end of its spindle is spigoted into the upper end of the sleeve and the drive is effected, in the usual manner, by means of a tongue and slot arrangement. The tongues and slots are eccentrically positioned, so that it is impossible to assemble the unit 180 deg out of phase.

Oil pump and lubrication system

The oil pump is secured to the lower face of the upper wall of the cell that forms the oil reservoir beneath the crankcase. It is spigoted into the mounting face to ensure accurate location relative to the spiral drive gear machined on the camshaft. The driven pinion that meshes with this gear is assembled on to the upper end of its 10 mm diameter spindle, to which it is pegged. Formed integrally at the lower end of this spindle, which is about 60 mm long, is the pump gear. The two pump gears are 7·5 mm thick and the lower end of their housing is closed by a cast aluminium cover retained under the body casting by the studs that secure it to the cell.

A cylindrical gauze is fitted beneath this cover and is retained by a dished retainer plate at its lower end and a shouldered stud screwed into a boss in the centre of the cover. This cylindrical gauze is located radially by a lip round the



On the extreme left is shown a cross section of the hydraulically-actuated tappet adjuster and, on the right, there are two diagrammatic illustrations, one of the oil circuit to the tappets and rockers, and the other illustrating the principle of operation of the split-sleeve type distributor valve. Between these are shown to a larger scale the two distributor valves, one in the oil pump outlet and the other in the inlet connection on the head

retainer plate and another round the edge of the pump cover. The maximum and minimum oil levels are about 10 mm and 39 mm below the top of this cylindrical gauze, and the pick-up is a tubular extension of the cover, the lower end of which is 42 mm below the level of the top of the cylindrical gauze. Access to the gauze, for cleaning it, can be gained through a cover plate bolted to an aperture immediately below it in the base of the oil reservoir. The drain plug is screwed into a captive nut in a small well in the centre of the cover plate.

From the pick-up, the oil goes through the pump and up through a 5 mm diameter, vertical duct to a passage drilled transversely from one side of the crankcase, through the rear wall to the rear bearing of the camshaft. A banjo union is screwed into the outer end of this passage to carry the oil to the rocker box on that side. The inner end of the passage is 4½ mm diameter and it takes the oil to an annular groove machined round the end of the camshaft. Another 4½ mm diameter passage takes some of the lubricant from the other side of this annular space to another banjo union that serves the rocker box on the left-hand cylinder. The remainder of the lubricant passes through radial holes in the base of the annular groove into the hollow crankshaft. Thence, it goes through two 3½ mm diameter holes drilled diametrically through the camshaft, one at each end. These holes intermittently line up with holes drilled vertically to the crankshaft main journal bearings. Some of this oil spills into circular traps which are spigoted into the outer faces of the end crank webs and enshroud the main journal bearing housings. From these traps, the oil passes through holes drilled in the crank pins to the big end bearings. The small ends are lubricated by splash.

Scavenge oil drains to the base of the crankcase and thence through a 14 mm diameter cored hole into the oil reservoir. Lubricant trapped in the annular cell round the breather valve passes through a 6 mm inside diameter × 8 mm outside diameter pipe directly to the oil reservoir. Some of the oil drains into the hole in which the oil pump is spigoted. Thence it passes through a slot cored in the side of the oil pump housing to a space round the spindle of the driven gear, which it lubricates. From this space, lubricant also passes through a drilled hole to the spindle of the drive gear.

Lubricant that passes to each rocker box goes through a banjo union and a hole drilled radially in the sleeve that houses the upper needle roller bearing for the torsion bar spring. It drains through the upper bearing, into the lower one and thence into the rocker box. The return into the upper end of the sleeve that houses the tappet is through the tube that houses the push rod. Thence the majority of the lubricant drains through a radial hole in the sleeve into a short duct leading to the oil reservoir, but some, of course, passes down the clearance between the tappet and the sleeve.

Some of the later versions of the Panhard engine have hydraulic tappet clearance adjusters. These adjusters, as can be seen from the accompanying illustration, are housed in the rocker boxes. Adjustment is effected by movement of the spherical seating sleeve of each rocker. The oil circuit is as follows. From the lubrication pump, there is a direct connection to the top of each rocker cover. This part of the circuit is given priority, so far as oil supply is concerned, by a distributor valve housed adjacent to the pump outlet. The valve comprises a resilient split-sleeve, which blanks off the passage connecting the duct that serves the rocker gear with another that serves the camshaft and main lubrication system of the engine. When the pressure in the line to the rocker gear rises above a certain value, it forces the resilient sleeve off its seating, and then the oil can also flow into the main lubrication system.

On the rocker box, the oil passes to a three-way connection, in which a second split-sleeve type distributor valve is housed. The priority circuit is to the two connections that serve the tappet adjusters; the distributor valve, which opens when the pressure in these connections reaches a certain value, regulates the passage of oil to the torsion bar springs and the bearings of their actuating arms.

The connection to each tappet adjuster goes to an annular space round the spigot base of a special dome-nut that seats in a shouldered hole in the top of the rocker box cover; this nut is screwed on to the end of the stud that carries the rocker. Thence the oil passes through radial drillings to the centre of the dome-nut, and down an axial hole in the stud. There is another non-return valve in this hole. A radial duct takes the oil into a cylinder formed in the upper end of the spherical seating sleeve. Spigoted into the upper end of this cylinder, to close it, is a guide nut, which is screwed on to the stud. A lock nut is tightened against the guide nut to fix its position. The cylinder is free to slide axially over the spigot, except inasmuch as it is constrained by the hydraulic pressure inside and a coil spring interposed between its end and the rocker cover.

The action of the hydraulic adjuster is as follows. When the engine is stationary and the oil pressure zero, the spherical seating sleeve is held in position by the return spring. In this condition, the clearance between the end of the spigot of the guide nut and the shoulder that forms its stop in the cylinder is not more than 0·1 mm, so axial movement of the sleeve is not great enough to interfere with the starting of the engine. As soon as the oil pressure builds up, it forces the sleeve firmly down on to the spherical seating on the rocker, thus taking up all clearance. This feature has been introduced to improve engine efficiency and to reduce noise under all conditions.

New Plant and Tools

Recent Developments in Production Equipment

FROM research into the action, performance, and life of cutting tools by various private and public bodies, and by the Production Engineering Research Association (PERA) in particular, it has been established that the blending of straight cutting edges with the nose radius of a tool is a major factor affecting the useful life of the tool. When the cutting edges are not truly tangential to the nose radius, the resulting discontinuities of the edge-form are the first to break down in operation. By taking special precautions to grind the tool correctly, it it possible to extend the tool life considerably. PERA designed a radius and cutting edge grinding attachment with which accurate forms for plain cutting tools could be readily produced. The optical equipment was supplied by C. Baker of Holborn Ltd., Metron Works, Purley Way, Croydon, and recently this firm has undertaken the production of the complete unit.

The attachment is fitted readily to existing machines, the base being ground for magnetic chucks and lugged for bolting to the machine table. Spigoted centrally in the base is a pillar fitted with a lever-operated clamp. A horizontal scale on a bevel at the base of the pillar registers with a setting line inscribed on the base. On the same centre line as the base spigot and at right-angles to it, the pillar is bored to accept the tool carrier plate and the optical system. This arrangement ensures that the tool carrier revolves about the optical centre of the microscope.

A second scale is carried on the horizontal sleeve which supports the tool carrier plate in the pillar and the setting line is inscribed on the pillar. To enable the carrier to be moved around its axis over a predetermined arc, two adjustable stops are fitted in a groove in the collar. These stops register with a fixed plate below the collar and can be set to the side cutting and plan relief angles. In addition to the stops a clamp is provided on the top of the pillar to lock the carrier plate in any position. This plate supports a cross slide with screw adjustments in two planes at right-angles. The tool is supported on a guide strip on the face of the cross slide table and secured by a lever-nut clamp.

The optical system is a simple microscope of low power mounted in a ground steel sleeve. Optical and mechanical axes are coincident so that when the microscope is mounted in the bearing of the tool carrier plate, the field of view is concentrically disposed to the axis of the bearing. A target graticule in the microscope has concentric rings that are numbered and correspond to radii in increments of 0·005 in.

Side and end relief angles are set on the horizontal scale on the base of the attachment. The angle is read directly from the scale and, when set, the central clamp is locked. This clamp remains locked for the remainder of the operation. The side cutting angle is set on the vertical scale and when the tool holder is vertical the scale reading is zero angle. The side cutting angle is read off in the clockwise direction and the stop on the spigot collar is adjusted so as to prevent counter clockwise rotation by engaging the fixed stop under the spigot. By continuing the rotation of the table after setting the first stop until the scale zero is again reached, the plan angle may then be set off on the other side of the zero mark. The second stop is then set in the same manner as the first.

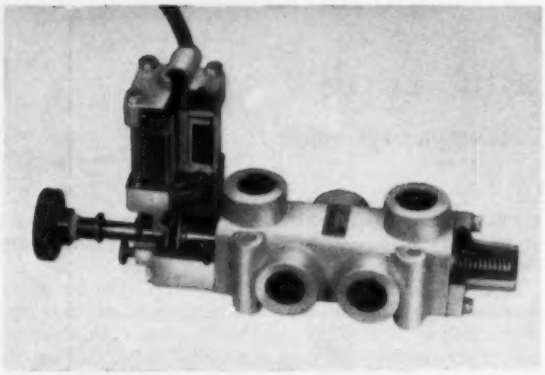
The angles may now be ground using the movements of the machine table. With the tool holder in the near-vertical position and clamped with the stop engaging the fixed stop, the side cutting and side relief angles will be simultaneously ground. By rotating the tool holder to engage the other stop, the plan and side relief angles may be ground.

When the angles are finished the coverplate of the microscope is swung aside and the tool nose brought into the centre of the field of view by adjusting the cross slide on which the tool is mounted. The required radius is selected on the ringed target and the tool adjusted so that the images of the cutting edges form tangents to the radius circle. After adjustment in this way the cross slide is clamped and the tool holder clamp at the top of the pillar is released so that the holder may be rotated about the microscope axis. The tool is advanced to the grinding wheel by the machine table feed and the holder rotated between the stops until the required radius is ground. The progress of the radius grinding may be observed with the microscope from time to time but the angular faces of the tool will touch the wheel at the moment the edges are truly tangential to the radius. This may be observed as the work progresses and the microscope is used for close inspection.

Solenoid valve with manual control

During installation, when testing, or in the event of a failure of the electric supply, it is often necessary to actuate a solenoid-operated valve. To meet such a contingency Baldwin Instrument Co. Ltd., Brooklands Works, Dartford, Kent, has recently introduced a solenoid valve having an overriding manual control. This is operated by depressing, with the palm of the hand, a large knob on a spindle that enters the valve casing through the end cover and makes

Baker-Pera tool radius and cutting edge grinding attachment
C. Baker of Holborn Ltd.



Solenoid valve with overriding manual control
Baldwin Instrument Co. Ltd.

contact with the pilot piston head connected to the valve spool.

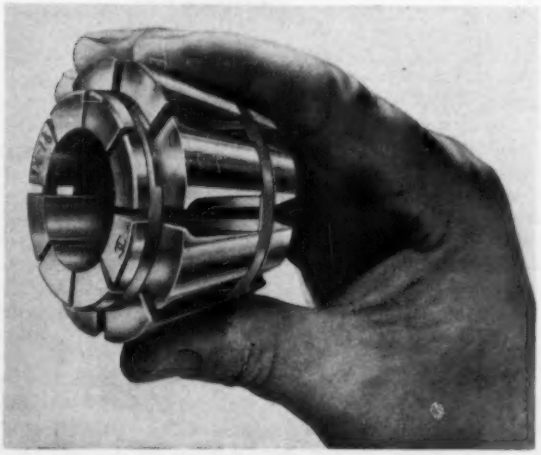
The spool is moved from the "normal" to the "operated" position and may there be locked by partial rotation of the override spindle which brings a D-shaped collar into position behind a locating screw. A detent ensures that the locked position is positively indexed and will not be released in the event of vibration occurring.

Since the spindle is not attached to the valve spool it is not reciprocated during the normal operation of the valve. At present the override feature is available as standard only on control valves of $\frac{1}{4}$ in and $\frac{1}{8}$ in bore. Apart from its use on solenoid valves it can also be incorporated in pilot-operated valves.

Hydraulic chuck and expansible collets

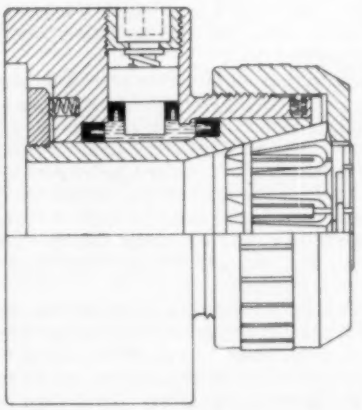
Multibore collets were patented in 1953 by the manufacturers, Crawford Collets Ltd., Tower Hill Works, Witney, Oxon, and have since been fully developed and tested under actual production conditions. They are now available in a range of sizes including all diameters from 0·125 in to 2·0 in, and also squares and hexagons. Each collet has a range of bore sizes of 0·125 in and can replace at least ten ordinary collets, including metric sizes. Actually seven Multibore collets can handle all stock, English and metric, from 0·125 in to 1·0 in diameter; ten are required to cover from 0·25 in to 1·5 in diameter; or fourteen for from 0·25 in to 2·0 in diameter.

Each Crawford Multibore collet has a gripping range over 0·125 in on the bore diameter
Crawford Collets Ltd.



The collet comprises eight segmental jaws but in the smaller sizes, for bores up to 0·375 in diameter, alternate jaws are relieved to leave four only effective for gripping the work. Each hardened and ground jaw is formed with an approximately semi-circular groove on each flank and adjacent jaws are spaced apart by a curved plate spring engaging the outer lips of the grooves. Against the expansion of these eight springs, the assembly is held resiliently together by two step-cut steel circlips. This relatively open and flexible construction is claimed to be non-clogging in operation and thus to confer an advantage additional to those possessed by a blade-type expansible collet.

Designed specifically for use with the Multibore collets, the Crawford hydraulic chuck is constructionally simple and has few moving parts. The coned sleeve receiving the collet is shouldered externally, and in conjunction with the recessed bore of the body forms an annular fluid chamber U-type sealing rings are fitted at each end of the chamber. In a single radial bore in the body, communicating with the chamber, is a small ram, sealed by another U-ring.



Diagrammatic section of the Crawford hydraulic chuck with a Multibore collet in position
Crawford Collets Ltd.

This is displaced by a square-threaded socket screw, turned by a key, to raise the fluid pressure against the shoulder of the sleeve and thus to close the collet. When the fluid pressure is released the coned sleeve is retracted, allowing the collet to open, by a series of helical springs loading a withdrawal plate screwed on the end of the sleeve.

It is claimed to have a more powerful gripping action than any other dead-length chuck. The exceptionally long bearing surfaces of the collet jaws remain parallel and in full contact with the work throughout their size limits. A simple adjustable collet rear support enables very short workpieces to be gripped effectively. With the support in position the work can be held on 0·125 in without any risk of the collet bell-mouthing.

Universal tool head

This new universal head enables such operations as boring, counterboring, facing, back-facing, turning, under-cutting, recessing, grooving and trepanning to be performed on a milling machine or a drill press as readily as on a lathe. The tool has a radial travel of $\frac{3}{4}$ in and with the extension tool block and a suitable bent cutter bar, as illustrated, it will cover a range of bores up to 12 in diameter.

Radial adjustment is effected, by means of a cranked key, through a sleeve engaging a rack and pinion. Depth of cut is adjustable by the micrometer ring, which can be set to zero

Newall universal tool head
Burton Griffiths and Co. Ltd.

at any point when starting the cut. The ring is graduated to 0·0005 in and, since the graduations are spaced approximately ¼ in apart, adjustment can be made with ease and certainty. In both cases, adjustment can be carried out without the need to stop the spindle rotation. It is merely necessary to grip the micrometer sleeve to arrest its motion and then to hold the sleeve by a tommy bar whilst making the adjustment.

The head is strongly constructed and is designed to provide a sustained accuracy, although it has a throw considerably greater than that usually available in such tools. It simplifies multi-operation work, as commonly components normally requiring several settings can be machined at a single setting, and frequently without requiring any special tools. For example, bosses can be turned on outside diameter, bored, faced, and back-faced by the tool head in one setting.

Manufactured by the Newall Engineering Co. Ltd., Peterborough, the head is marketed solely by Burton, Griffiths and Co. Ltd., Small Tool Division, Montgomery Street, Birmingham 11.

Automatic rack miller

This versatile Donau milling machine, type UZFM, enables racks, notched bars, ratchet bars and broaches to be machined economically on automatic cycles. The saddle is mounted on a swivel block and can be set to a maximum of 30 deg to either side of the normal position for right-hand or left-hand rack teeth. Additionally, the spindle block can be swivelled through 10 deg to the right and 30 deg to the left of vertical so that relief milling can be performed on broaches or on saw-type serrations.

On the large T-slotted table, work up to 79 in long can be clamped, enabling a working length of 71 in to be milled in one continuous cycle. Racks of greater length can be handled on the machine by re-clamping. Saddle feed is hydraulically operated by a 1 kW motor and pump and is steplessly variable from zero to 11·75 in/min. A mechanical drive from a 2·2 kW motor is provided for the spindle, giving speeds of from 31·5 to 450 rev/min. All drive gears in the spindle block are hardened and ground.

There is automatic compensation for backlash between the lead screw and the indexing gear train which is driven by a 0·25 kW motor. When the preset number of teeth have been cut the table is returned automatically by rapid traverse, at a constant speed of 85 in/min, and the machine is stopped. Indexing is controlled by push button, with selector switches for left-hand or right-hand operation, and for manual or automatic cycle. A third switch enables the selected indexing value to be instantaneously doubled or quadrupled; from module 1·25 to modules 2·5 or 5·0, for instance. An electrically controlled pendulum milling device enables work up to 31·5 in long to be milled automatically on two fixtures.

Limit positions of the cutter spindle axis above the table are 2 in and 8·5 in. Cutters of from 4·0 in diameter plus twice the milling depth to a maximum of 6·312 in diameter

Donau automatic rack-milling machine, type UZFM
Elgar Machine Tool Co. Ltd.

can be accommodated, to a width of 4·0 in between spindle supports and a width of 2·0 in before the outer support. Teeth up to module 6 (circular pitch 0·742 in) can be milled from the solid in steel of approximately 38-ton tensile, and up to module 8 (circular pitch 0·989 in) in cast iron.

Built by Donau-Werkzeugmaschinen Erich Arndt, Ulm (Donau), Germany, the machine is factored by Elgar Machine Tool Co. Ltd., 172-178 Victoria Road, Acton, London W.3.

Filing and trimming machine for non-ferrous metals

A new type of machine for fettling, shaping, filing or trimming non-ferrous metals is now being produced by Stanley Works (Great Britain) Ltd., Rutland Road, Sheffield. It is specifically designed for shaping those metals and materials that are not readily cut by abrasive wheels or by normal files. Lead, zinc, aluminium, brass, copper and their various alloys are cut at a high rate of stock removal; as also are all the commonly used plastics materials, whether of the thermosetting or the thermoplastic types. Other applications are for woodworking, pattern-making, and cutting leather or hard rubber.

The outstanding feature of the new machine, which is termed the "Discut" and is available in either pedestal or bench models, is the perforated, thin steel cutting disc. On this 10 in diameter disc the pattern of the cutting teeth forms three separate but concentric spirals. The spiral arrangement ensures that the cut traverses the work to leave a smooth, well finished surface. The disc is supported on a spoked backing plate; the spokes serving as vanes tending to draw air through the tooth perforations of the disc and to keep it cool in operation. Although not intended, or recommended, as a regular practice, the quality and the heat treatment of the disc material are such that even steel can be cut.

Operating from any standard supply, the disc is driven by an electric motor through a reduction gear at 400 rev/min. This speed has been found suitable for varied general purposes, but other speeds can be arranged for specific applications. The swarf comes away from the work as chips rather than dust; an important consideration when costly and recoverable materials are being cut. In most applications it is unnecessary to provide dust extraction equipment.

Stanley "Discut" machine for filing or trimming non-ferrous metals, wood, and plastics materials
Stanley Works (Great Britain) Ltd.

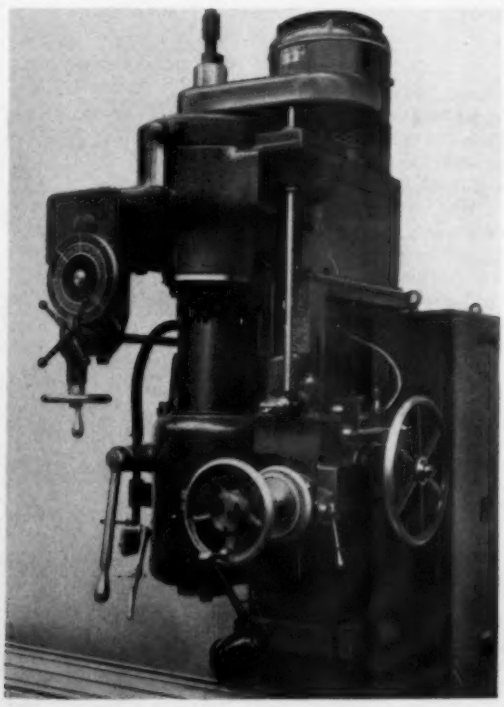
Automatic down-feed for vertical milling machine

Having a wide range of spindle speeds and a comprehensive range of automatic feeds to longitudinal and transverse motions, associated with a general robust construction, the No. 47V vertical milling machine manufactured by Alfred Herbert Ltd., Edgwick Works, Coventry, has proved suitable for work extending from light precision operations to heavy cutting with carbide tools. Its capacity is 48 in × 16 in × 23 in.

To increase its field of application, the spindle head can now be fitted with an automatic power-operated down-feed unit. With this new unit any combination of holes in the vertical plane, and at five levels, can be drilled and accurately bored during the same setting as for the milling operations. The unit does not convert the machine into a jig borer, but it enables machining accuracy relative to the basic alignments of the machine to be obtained easily. This simplifiies a fundamental machining practice, common in most toolrooms and requiring considerable skill, of holding close tolerances between surfaces normally machined in two operations on different machines.

An indexing barrel, having five adjustable screw stops for milling up to five levels at one setting, is used to trip the down-feed of the spindle. Three rates of down-feed are provided, at 88, 165 and 330 cuts per inch. A large micrometer dial, if set to zero at the commencement of the cut, will register the depth of hole drilled or bored. The feed shaft is driven by a vee belt and reduction gearing from the spindle, thus maintaining correct ratio between the speed and feed.

Herbert No. 47V vertical milling machines with automatic power down-feed to spindle head
Alfred Herbert Ltd.



AIR SUSPENSION FOR SEMI-TRAILERS

New Tandem, Trailing Arm Design Introduced by Cranes (Dereham) Ltd.

AN established feature of the semi-trailers, of all types and including frameless tankers, manufactured by Cranes (Dereham) Ltd., of Dereham, Norfolk, has been the independent, trailing arm suspension system. Each wheel is carried by a fabricated, box-section arm which is pivotally mounted on oversize spherical-roller bearings on transverse shafts on the suspension sub-frame. These bearings relieve the springs of all lateral stresses and also of the brake torque reaction.

Recently the tandem version of this design, intended for payloads of 16 tons within the legal limit of 24 tons gross weight, has been developed to incorporate air suspension units instead of the conventional leaf springs. When coupled to a Leyland Beaver tractor a payload of 17 tons can be carried. The first semi-trailer equipped with the new suspension system has been delivered to British Road Services. It is of the standard Crane pattern, with a pressed steel frame and a 24 ft light-alloy platform. The four wheels are shod with twin 9.00×20 tyres and the unladen weight of the semi-trailer is 2 ton 17 cwt. Similar air suspensions of larger or smaller capacity can be supplied to the same, patented, design and a modified arrangement is available where a single pair of wheels only is required.

Advantages claimed for the earlier, mechanical, trailing arm system were:

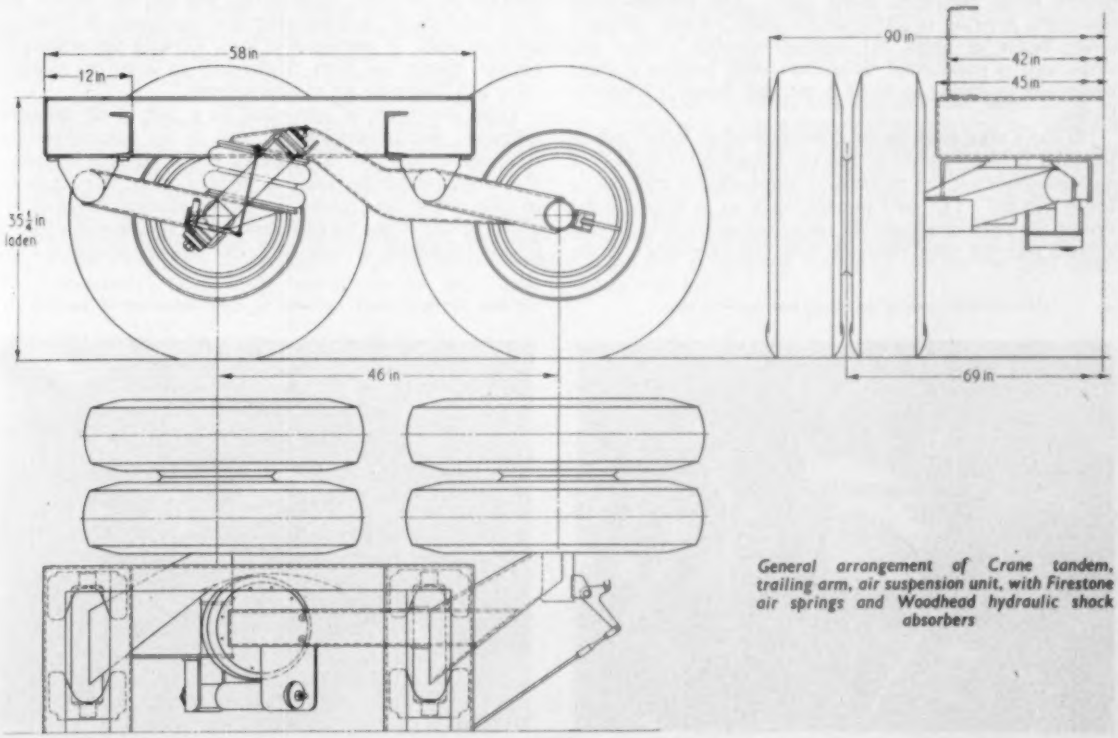
1. All wheels were on independent stub axles and the layout ensured the maintenance of an even load distribution
2. The springs were required to carry vertical loads only
3. All radius arms were of the trailing type, allowing the wheels to ride easily over obstacles
4. Stability was improved
5. There was no transference of load during braking
6. The complete suspension was built up on a sub-frame, readily detachable from the trailer frame as a complete assembly to reduce shipping dimensions.

Advantages of pneumatic suspension

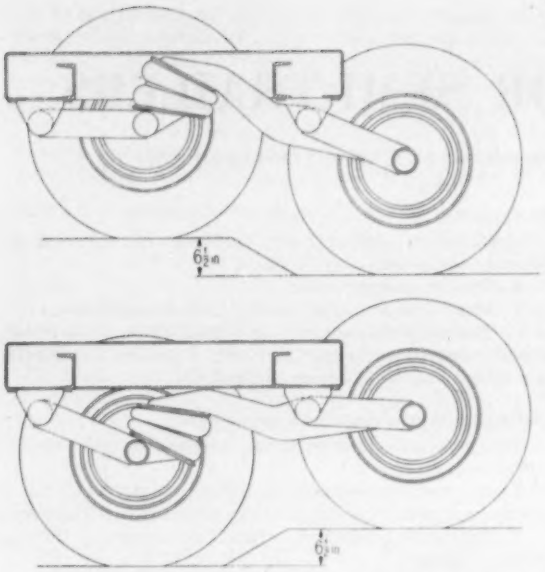
With the incorporation of air suspension units further advantages accrue:

1. Automatic adjustment to variation of load. The ride is virtually as smooth when travelling light as when under load
2. Improved spring characteristics, giving smooth running when unladen
3. A constant platform height is maintained
4. Weight is reduced
5. On heavily cambered roads the tendency to tilt is automatically corrected
6. All compensating link movement is taken by the air bellows. There is no sliding friction and no lubrication is required at this point.

Only two air springs are employed in the Crane design, each absorbing the road shocks from a tandem pair of wheels. The units fitted are Firestone "Airide", two-convolution bellows; a type that has been in service for some time in the U.S.A. In that country they have given highly satisfactory performance on long-distance coaches and have been replaced,



General arrangement of Crane tandem, trailing arm, air suspension unit, with Firestone air springs and Woodhead hydraulic shock absorbers



Normal limits of articulation on the Crane tandem wheel design using a single air spring

although still serviceable, after operation over 500,000 miles.

The line drawing shows in section one of these bellows at its levelled height of 7·25 in and outside diameter of 13·94 in. At extreme bump and rebound positions the height is 2·75 in and 11·25 in respectively. It comprises a carcass of oil-resistant rubber, reinforced by two plies of nylon cord and produced in similar manner to a tyre casing. A steel bead at each end is engaged in a studded bead ring and, centrally, a tubular, inexpansible girdle ring is fitted to restrict radial expansion under load. The recommended maximum pressure is 100 lb/in² for static loading, giving a safety factor of about 5:1 against bursting. Since the suspension is pressurized from the vehicle braking system, commonly operating at 80-85 lb/in², this factor is normally higher.

On the Crane semi-trailer a pressure of 45 lb/in² only is required in the bellows to sustain a load of 17 tons. At no-load condition the pressure is automatically reduced to about 5 lb/in². The only periods when air is added to the system are when increasing the static load or when traversing a bend and the time taken exceeds the time delay of the levelling valve. These requirements are well within the capacity of the braking system air compressor. A safety device ensures that the braking reservoir is charged before air is passed to the suspension system and also that a leakage from the suspension system will not affect brake operation.

Novel mounting arrangement

In the modified tandem wheel suspension the air bellows is located between support plates welded respectively on a rearward extension of the front trailing arm and a forward-extending arm welded up as a unit with the rear trailing arm. This additional member on the rear trailing arm, carrying the upper support plate, is sealed to form a surge tank for the air spring. The surge tank volume influences the rate and frequency of the air spring and consequently the bump load. On the Crane suspension the volume is arranged to give a spring frequency of 90 c/min, a value selected as the optimum wheel frequency for the particular application. The curve showing the effect of surge tank volume on frequency does not relate specifically to the spring used on the Crane suspension but to a somewhat smaller bellows, but is typical in character.

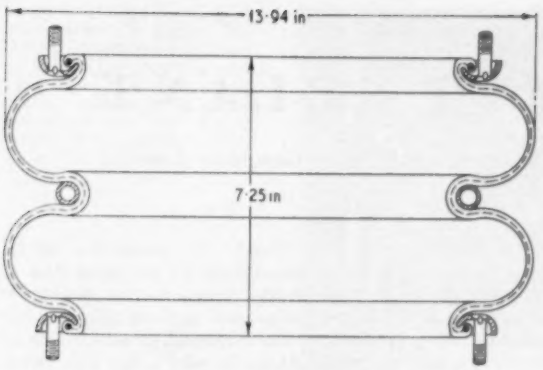
Similar remarks apply to another curve showing the effective area and volume characteristics of a two-convolution air spring, which is also typical but not specific. Both curves relate to a spring having a volume of 590 in³, which will support a load of 5,000 lb with a pressure of 74·6 lb/in² gauge. With no surge tank the spring, at the levelled position, has a rate of 1,700 lb/in and a frequency of 107 c/min, and the bump load is 34,000 lb. By adding a surge tank of 1,770 in³, that is, three times the bellows volume, the rate is lowered to 900 lb/in, the frequency to 79 c/min and the bump load to 9,600 lb.

Each bellows is provided with a levelling valve, controlling automatically the admission or discharge of air. The valve is mounted on the extension of the rear trailing arm, above the bellows, and the actuating lever is linked to a bracket on the lower support plate on the front trailing arm. An increase in the load, compressing the bellows, moves the lever upwards to open the inlet valve and admit air from the pressure tank. A reduction of load, allowing the bellows to expand, moves the lever downwards to open the exhaust valve and discharge air to atmosphere.

Valve movement is controlled by a pair of oil damping cylinders, communicating by way of an adjustable-area, restricted orifice. Actual operation of the valves is by means of a tilting cylindrical member, pivoted on the lever spindle. In each end of the cylinder is a sliding element linked to the piston of one of the oil cylinders. The sliding elements are loaded by helical springs from the central, actuating lever

Off-side view showing air spring and levelling valve

Off-side forward wheel removed to show mounting of trailing arm



Section of Firestone "Airide", two-convolution air spring

Air springs and hydraulic shock absorbers, viewed from rear at low level

cam, and the speed at which the appropriate valve is operated depends upon the build-up of sufficient energy in the helical spring to overcome the resistance to flow of oil through the restricted orifice. A needle-type valve at the restricted orifice enables the consequent delay period to be adjusted to the specific requirements of a particular installation. It may be set for a delay up to about 20 seconds.

Relative movement between front and rear trailing arms, and movement in and out of parallelism of the support plates, is accommodated during operation by flexure of the bellows. There are no shackles or links as required on the mechanical suspension. Normal limits of articulation for the tandem wheels permit a relative rise of 6·5 in for either wheel. In these positions pairs of bump rubbers, located inside the air spring are brought into abutment. Four bump pads are mounted in each support plate. The pads also serve to prevent a total collapse of the bellows in the event of loss of pressure for any reason.

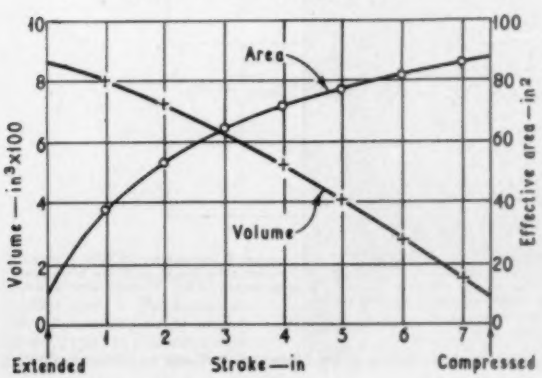
The possibility of loss of pressure occurring as a result of perforation of the bellows by flying road debris would, from the American experience, appear to be remote. Under any circumstances the operating conditions of the bellows would be less arduous than those of the tyre casings. Nevertheless, there is some concern to guard against the conceivable hazard of a sharp flint or a piece of metal lodging in the bellows carcass and being repeatedly trapped between the convolutions until penetration is effected. On other applications both telescoping metal covers and fabric sleeves have been tried out. For the Crane system a flexible rubber sleeve enshrouding the bellows has been proposed and is now undergoing development. (On the illustrations an experimental fabric bag, rolled up to the upper support plate to reveal the bellows, may be discerned.)

At a recent demonstration, staged on the dilapidated and overgrown runway of an abandoned airfield, the performance of the air-sprung semi-trailer coupled to a Leyland Beaver tractor was impressive. Simultaneous runs at the same speeds were made by two vehicles, the trailer units of which were equipped respectively with the new air suspension and the earlier version of the trailing arm design with conventional leaf springs. The virtual absence of bounce, the marked reduction of noise, transmitted shock, and vibration on the air-sprung unit was outstanding. In comparison with the companion vehicle, the improvement was, of course, the more obvious when the vehicles were run in the unladen condition.

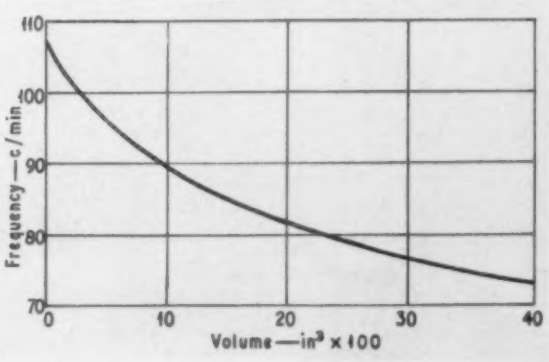
Riding on the platform of the conventionally sprung trailer occasioned acute discomfort; on the air-sprung unit the ride was relatively much smoother and quite tolerable. It was most noticeable that riding conditions were markedly better at the rear of the platform than at the forward end over the fifth wheel. From this phenomenon the obvious inference was drawn.

Tracking of the trailer unit was uniformly good under all conditions, even when a sharply sinuous course was followed at a relatively high speed. In braking demonstrations, the fully laden air-sprung vehicle was brought smoothly too rest, without any tendency to side-swing, with all brakes applied and also with the trailer brakes only operative. This was also the case when an emergency stop was demonstrated and the driving wheels of the tractor were inadvertently locked.

Effective area and volume characteristics of typical bellows



Influence of surge tank volume on air spring frequency



VEHICLE TEST PLANT

A Heenan and Froude Development for The Associated Ethyl Company Limited

DURING the past few years there have been considerable improvements in the efficiency and performance of internal combustion engines. They have emphasised the need for further research into the various factors that effect the overall performance of a vehicle, including, of course, the correct matching of fuels and engines so that both may be utilised to the fullest extent and maximum fuel economy be achieved.

The information needed to determine the actual performance of a vehicle can be obtained only by putting the vehicle through a series of tests repeated under identical motoring conditions. Ideally, the tests should be carried out on the road, but variations in road surfaces, traffic conditions and weather render accurate reproduction of a previous test virtually impossible. Even a private outdoor test course, with complete freedom from variation in traffic conditions, is not wholly satisfactory.

Some tests can, of course, be made only on the road. Others, however, can be carried out more accurately, more conveniently and more economically by means of an indoor test plant that enables research to be conducted under accurately controlled conditions which can be precisely reproduced as often as required. It is to meet this need for controlled tests that Heenan and Froude Limited, of Worcester, have built and installed a new vehicle test plant for the Engine Laboratory at Bletchley of The Associated Ethyl Company Limited.

This test plant is not intended to be a comprehensive substitute for normal road testing, but it does overcome many of the difficulties encountered in the course of conventional testing routines. Furthermore, it provides means for obtaining certain information that could not be obtained accurately on the road. For example, the plant permits accurate measurement of the amount of power actually leaving the driving tyres and reaching the road (drum) surface, which cannot be accurately measured by road testing techniques.

The new Heenan and Froude test plant has several advantages over previous installations for the same class of research. It has been specifically designed to be suitable for a wide range of vehicle sizes and test conditions. For example, the power drums will withstand an axle weight of eight tons and are wide enough to take a fair size motor coach, while at the other end of the scale the plant has been used for testing vehicles as small as a car with a 750 cm³ engine. The plant is also capable of operation with high speed vehicles—a special car has been run at 140 m.p.h. In addition, cars with either front or rear wheel drive can be accommodated, and because of the flexibility of the air duct, rear-engined vehicles present no difficulty.

Some of the more unusual design features of this plant are:

(1) The use of a two-speed, heavy-duty, commercial vehicle type rear axle for carrying the two power drums. This arrangement gives the following advantages:

(a) The speeding up of the propeller shaft (by the rear axle ratio) to drive the dynamometer for loading the vehicle. As a result of this the dynamometer is of a smaller and cheaper type than would otherwise be required.

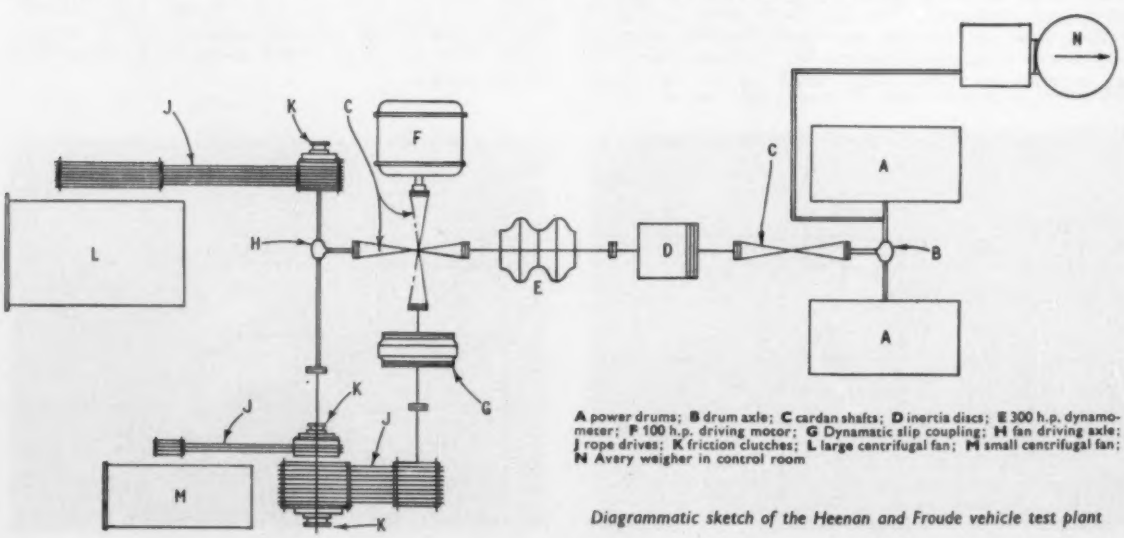
(b) The two-speed rear axle increases the range of powers and speeds provided by the dynamometer.

(c) The rear axle, freely mounted in trunnion bearings and equipped with torque measuring gear, enables accurate measurement to be made of the power transmitted through the drums.

(d) As the dynamometer runs at a higher speed than the drums, lighter and smaller inertia weights can be embodied than would be the case if the weights were attached to the drum shaft. Thus it is easier to remove or add weights to simulate the inertia of various vehicles.

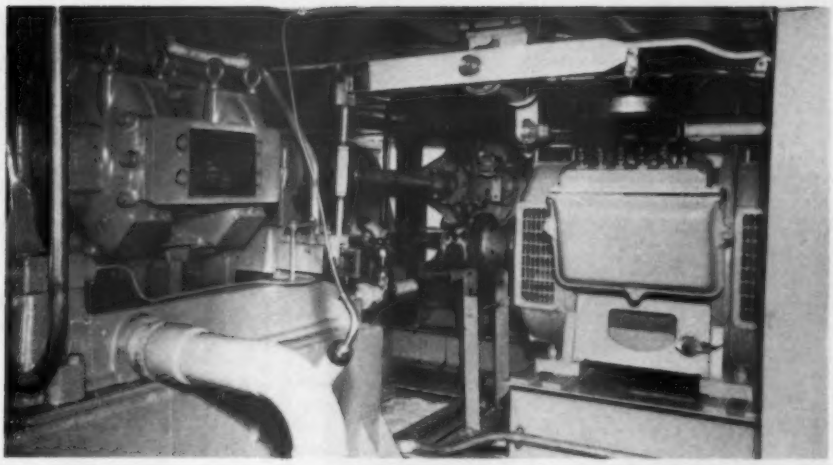
(e) Power for the driving fans for cooling the vehicle radiator is conveniently provided from the propeller shaft.

(2) The dynamometer itself, which is of the Heenan-Dynamatic eddy-current type under electronic control,



A power drums; B drum axle; C cardan shafts; D inertia discs; E 300 h.p. dynamometer; F 100 h.p. driving motor; G Dynamatic slip coupling; H fan driving axle; J rope drives; K friction clutches; L large centrifugal fan; M small centrifugal fan; N Avery weigher in control room

Diagrammatic sketch of the Heenan and Froude vehicle test plant



A view in the basement where all the machinery is housed. The 300 h.p. dynamometer is shown in the left foreground of this illustration; the axle for driving the fans is shown in the middle background and the driving motor in the right foreground

incorporates quick change-over facilities for "propeller law" to "constant speeding" characteristics.

(3) The use of a further and smaller rear axle, driven from the propeller shaft of the drum axle, to drive either of two cooling fans, using the power of the vehicle itself. Each fan is provided with inlet dampers, adjustable from the main control room, to give any air-blast required up to 80 m.p.h.

(4) The use of a Heenan-Dynamatic eddy-current, variable-speed coupling to control the speed of either fan if, for any reason it is desired to drive the fan electrically instead of from the vehicle engine.

(5) The same electric motor and Heenan-Dynamatic coupling can be used for motoring the vehicle for "overrun" tests.

(6) In special circumstances, when the power of the vehicle engine is insufficient to drive one of the fans at the fan-duty required, the electric motor and Heenan-Dynamatic coupling can be used to provide the needed additional power.

(7) A small, portable electronic controller that enables the driver of the vehicle to regulate the dynamometer load from the driving seat and hence the regulate resistance against the vehicle on test.

(8) To allow tests at high speeds to be continued for long periods without harm to the tyres, separate electrically driven fans can provide a cooling air-blast over the tyres of the driving wheels.

(9) By means of ducts and dampers built into the test house, the warmed air leaving the vehicle radiator can be partly or wholly conducted back to the fan inlet, thus providing a means for testing under conditions slightly warmer than ambient.

Briefly, the test plant had to meet the following conditions to satisfy the requirements of The Associated Ethyl Co. Ltd.:

(a) It had to have a wide range of powers and speeds.

(b) It had to have a wide range of mass inertia loads for control of acceleration testing of most present-day and projected vehicles.

(c) There must be means for supplying and regulating an air blast to the radiator grille to simulate the normal engine air cooling experienced on the road at various speeds.

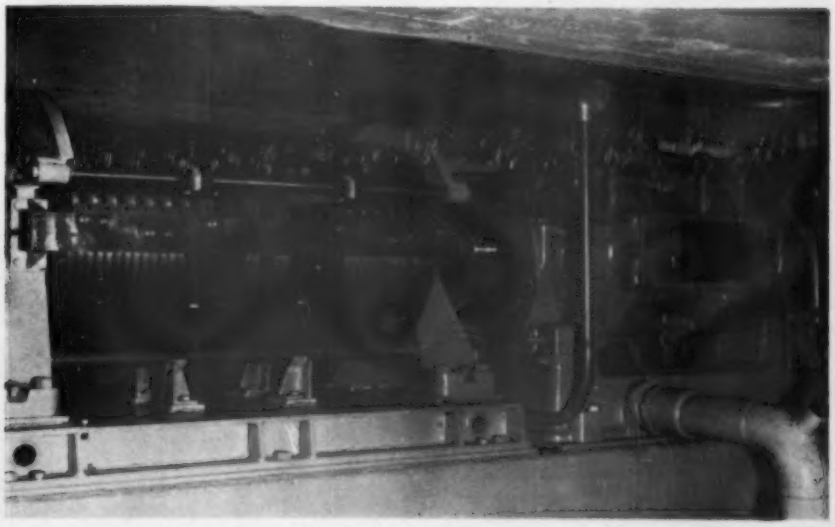
(d) The plant must be suitable for extended endurance tests at high speeds and powers.

(e) "Motoring" facilities must be provided to permit the application of "reverse torque" loading to the transmission and engine of the vehicle and to simulate conditions of "overrun".

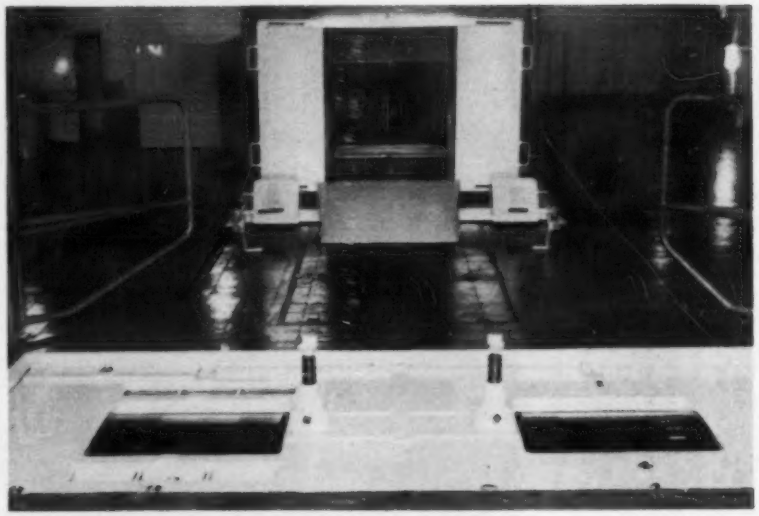
(f) A rapid change-over from "absorbing" to "motoring" conditions, without alteration of vehicle speed.

(g) Provision for variable load/speed characteristics for both "vehicle driving" or "vehicle driven" tests, these including "constant speeding", "constant loading" and "cube-law" features.

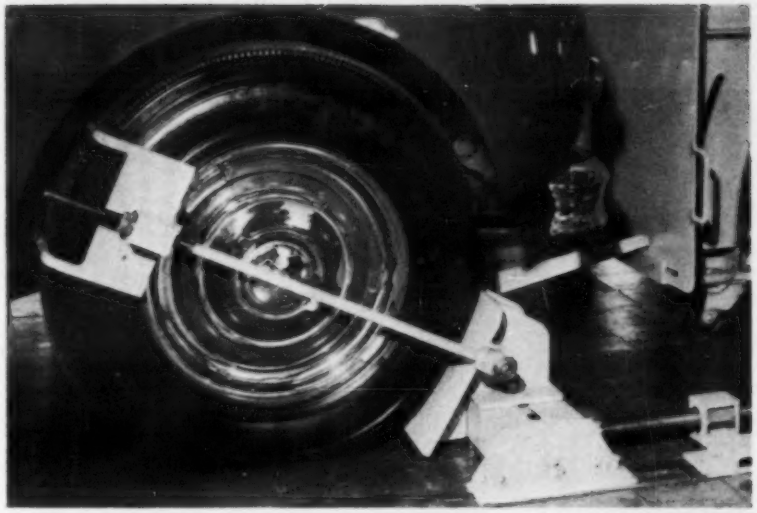
(h) A comprehensive instrumentation system, together with



Another view in the basement. The dynamometer can be seen on the right and the disc weights for adjusting the inertia on the left

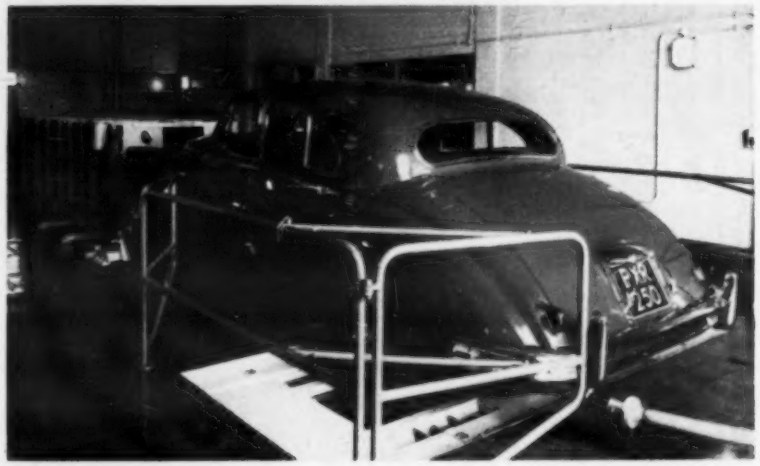


A general view of the test house showing the power drums in the foreground and the adjustable air duct in the centre



The front wheels of the car on test are clamped in position. The clamps are adjustable to suit a wide range of vehicles

A Jaguar car ready for test, with the rear wheels in position on the drums



This shows the safety jacks that take the weight of the car if tyre failure occurs

accurate indication of the torque available at the vehicle driving-wheel tyres and the load applied against the vehicle by the dynamometer.

To meet these requirements, an unusual basic design has been adopted. The vehicle driving wheels rest upon and drive two steel drums mounted on the half-shafts of an Eaton two-speed, heavy-duty commercial vehicle rear axle in which the differential gears are locked. The drums are 48 in diameter × 24 in wide and are separated by a 32 in gap. They are fabricated in mild steel, are dynamically balanced and are capable of running continuously at equivalent road speeds up to 140 m.p.h. and of supporting an axle load of up to eight tons. The drum axle has ratios of 4·5:1 and 6·14:1.

Through a needle roller, universally jointed cardan shaft, the pinion shaft of the drum axle is coupled to an inertia-disc assembly and then by a gear-tooth coupling to a Heenan-Dynamatic dynamometer. In effect, the axle is running in reversed-torque conditions, the cardan shaft revolutions being increased (compared with those of the drums) according to the gear engaged. This permits a smaller size of dynamometer to be used, since the power-absorbtion capacity of a diameter increases with speed.

The drum axle is freely mounted in two trunnion bearings. It is fitted with a torque-arm, which is connected through reversing links, pull rods and a twist shaft, to a springless weigher in the control room. The reaction torque on the axle casing is registered on the weigher. It is equivalent to the effective torque applied by the driving wheels at the "road surface" of the drums. This effective road surface torque is, of course, the vehicle driving torque, and is equivalent to the torque leaving the axle of the vehicle on test, less the inevitable losses due to tyre rolling resistance, etc.

The driving shaft that carries the forged steel inertia discs is mounted on ball and roller bearings housed in independent bearing pedestals. There are 30 discs, each 17½ in diameter × ¾ in thick and weighing 37 lb. They are equally disposed about a central collar on the shaft, and any number can be bolted to the collar or withdrawn out of use. This allows simulation of the inertia of vehicles of differing weights.

When the 6·14 ratio of the drum axle is engaged, each additional disc increases the inertia at the drum by 378 lb-ft² (equivalent vehicle weight 94·5 lb); when the 4·5 ratio is engaged each aditional disc increases the inertia at the drums by 202·5 lb-ft² (equivalent vehicle weight 50·6 lb). The maximum and minimum inertia values for the complete assembly referred to the drum shaft are as follows. The minimum inertia for small vehicles (drum axle 4·5 ratio and small fan running) is 6,720 lb-ft², corresponding to a vehicle weight of 1,680 lb. For large vehicles the minimum inertia of assembly is 7,400 lb-ft² (vehicle weight 1,850 lb) and the maximum is 18,000 lb-ft² (vehicle weight 4,500 lb; in both cases the 6·14 drum axle ratio is engaged and the large fan is running).

The rotational speed of the inertia disc assembly can reach 6,000 r.p.m.; therefore most accurate dynamic balancing of the individual discs in their various possible combinations on the driving shaft is carried out.

A Mk. 11 Heenan-Dynamatic eddy-current type dynamometer is used. It is capable of absorbing a maximum of 300 b.h.p. over a speed range of 2,400 to 6,000 r.p.m. Both the load and speed are remotely regulated electronically from the control room. Connection between the inertia-disc shaft and the dynamometer is effected by means of a gear-tooth flexible coupling. The other end of the dynamometer shaft is connected though a cardan shaft with flexible couplings to a second Eaton two-speed commercial truck rear axle with a locked differential. This axle has ratios of 4·5:1 and 6·25:1. Its half-shafts carry multi-vee belt pulleys for the drives to two centrifugal fans for supplying the vehicle radiator cooling air.

One of the fans absorbs 90 b.h.p. when running at 600 r.p.m. and delivering 64,000 ft³ of air per minute; the other absorbs 7½ b.h.p. at a speed of 645 r.p.m. and delivers 12,000 ft³ of air per minute. Either fan can be connected to its drive by means of a friction clutch pneumatically operated from the control room. By regulation of the fan inlet dampers, air speeds up to 80 m.p.h. are obtainable at the vehicle radiator grille.

Both fans feed into a common air duct, which has an outlet area of 9 ft² at the end adjacent to the vehicle. The ducting in the vehicle test room is adjustable in length to suit the various sizes of vehicle, and the end adjacent to the vehicle is fitted with adjustable vanes to direct the air blast as required to suit the vehicle on test. Two separate fans, with associated ducting, supply air for tyre cooling purposes. From these fans the air is blown directly on to the tyres from both back and front.

For motoring the vehicle, a 100 b.h.p. squirrel-cage, constant-speed motor is provided. It is coupled through a needle-roller type cardan shaft to a variable-speed Heenan-Dynamatic eddy-current coupling to give a maximum output of 95 b.h.p. at 1,375 r.p.m. The output member of the coupling is connected via a rubber-bush type flexible coupling to a multi-vee belt pulley from which vee belts drive an extension shaft coupled to one of the half-shafts of the fan driving axle. This drive is transmitted through the fan-axle gears, the dynamometer, the inertia-disc assembly, and the drum-axle gears to the drums, which then motor the vehicle mounted on them.

A pneumatically controlled friction clutch, operated from the control desk, enables the motoring facilities to be switched in and out as desired. The Heenan-Dynamatic coupling, also operated from the control desk, gives infinitely variable control of motoring speed.

To hold them against rotation while a vehicle is being run on or off, the drums are fitted with pneumatically operated brakes. When the vehicle is set in its final position it is firmly anchored at its front wheels by clamping devices adjustable for varying tyre sizes, wheelbases and tracks. There are also safety jacks under the rear axle to provide support in case of tyre failure. These features can be seen in some of the accompanying illustrations. A louvred panel in the side of the building admits fresh air from outside into the basement where the fans are housed. A similar panel in the main access doors to the vehicle room above allows the cooling air to be exhausted after passing over the vehicle. Two louvred panels in the floor of the vehicle room, and remotely operated from the control room, permit recirculation of cooling air between vehicle room and basement, thus allowing for regulation of cooling air temperature.

A small portable electronic control unit is provided for regulating the dynamometer load from the driving seat in the vehicle under test. Apart from this unit, all loads, speeds, air blast and other conditions are set and adjusted from the control room, which is on the test room floor level to the offside of the vehicle. The control panel is fully instrumented and is conveniently placed adjacent to the two dials that register drum-axle torque and dynamometer load.

Other features incorporated in the plant include an exhaust-gas collector system for the vehicle, temperature regulated oiling systems for both axles, water supply and return system for the dynamometer and a Heenan water cooler. This last item of equipment provides re-cooled water for the dynamometer and for the oil cooling system. It renders the test plant almost completely independent of the supply from the two mains, and at the same time reduces the water costs. It also serves various circuits that are independent of the vehicle test plant.

This new British plant, because of its flexibility, the wide range of vehicle sizes that it can accommodate, and the variety of test conditions it can reproduce, is one of the most advanced in Europe. Both The Associated Ethyl Company Limited and Heenan and Foude Limited are deserving of the heartiest congratulations.

VACUUM BRAKE RELAY VALVE

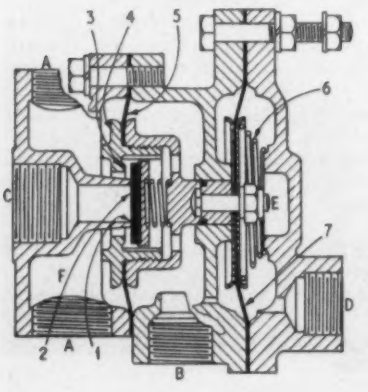
A device to Effect an Improvement in the Overall Performance of the Vacuum Triple Braking System

RECENTLY, the Clayton Dewandre Co. Ltd., of Lincoln, have introduced a new valve for incorporation in the well-known vacuum triple braking system. As installed hitherto, the standard system comprises simply a vacuum master servo operating mechanically on the rear brakes and pneumatically on separate cylinders mounted on the stub axles of the front wheels, with the vacuum supply to the cylinders on the front wheel stub axles regulated by the distributor valve in the vacuum servo. In recent years, the tendency for vehicle manufacturers to increase the proportion of braking applied to the front wheels has led to the introduction of the tandem type, front wheel cylinders. This increase in the volume of the front wheel cylinders, in addition to the distance between the cylinders and the master servo, has aggravated the slight but nevertheless undesirable time lag inevitably experienced with vacuum-actuated braking systems.

The new relay housing has been introduced to reduce this time lag. It is normally mounted as close as possible to the front wheel cylinders, and generally replaces the T-junction, where the pipeline from the servo is connected to that between the two wheel cylinders. If the main reservoir is situated a long distance from the relay valve, it may be desirable to introduce a secondary reservoir close to the valve. The additional reservoir is not necessary, however, if the main reservoir is reasonably close to the relay valve and the pipe between the wheel cylinders reasonably short. An accompanying illustration depicts a layout incorporating a secondary reservoir.

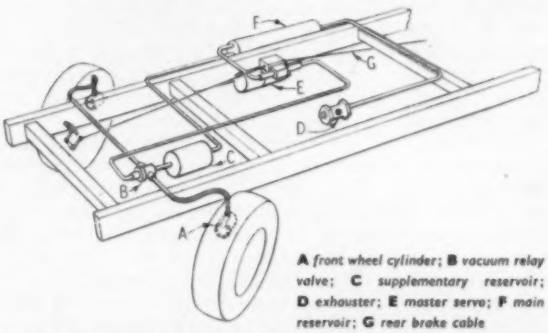
Another illustration shows a cross section of the relay valve. The two ports A are for the connections to the front wheel cylinders, and port C communicates with the secondary reservoir. At the opposite end of the valve unit, the port D is connected to the distributor valve of the lightweight type servo, or, if the servo is of the monobloc type, to the end cover. The degree of vacuum supplied through this port is proportional to the effort applied to the brake pedal. A breather or filter is fitted to the atmospheric port B, to prevent dirt from entering the valve.

The relay valve comprises a body and two end covers. Rubber diaphragms are clamped between these end covers and the body. A cage assembly 4, in which is carried a rubber-faced disc valve 2, is clamped between the centres of the two diaphragms, which it couples together. The rubber-faced disc performs the functions of both the atmospheric and vacuum valves. One of the valve seats is formed by the end face 1 of the vacuum port C, while the other, which is the atmospheric valve seat, is formed by the face 3 in the cage. The two diaphragms, 5 and 7, are biased towards the port C by the spring 6.



Cross section of the relay valve, showing the cage assembly mounted between the centres of the two flexible diaphragms

When the brakes are off, the valve is in the position shown in the diagram. The vacuum from the secondary reservoir maintains the spring-loaded disc valve 2 against the vacuum face 1. At the same time, the front wheel cylinders are connected through the ports A to the chamber F and, through the open atmospheric valve 3 and the holes in the cage, to the atmospheric port B.



A *front wheel cylinder*; **B** *vacuum relay valve*; **C** *supplementary reservoir*; **D** *exhauster*; **E** *master servo*; **F** *main reservoir*; **G** *rear brake cable*

Sketch illustrating a proposed layout of the Clayton Dewandre vacuum-actuated brake system incorporating the new vacuum relay valve

As soon as the brakes are applied, vacuum from the master servo is communicated through the port D to chamber E. This moves the diaphragm assembly against the compression in the spring 6. The initial movement causes the atmospheric valve 3 to seat on the disc, and subsequent movement lifts the valve from the seat 1 to admit vacuum from the secondary reservoir through the chamber F to the front wheel cylinders. When the vacuum operating on the diaphragm in chamber F, together with the load in the spring 6, balances that on the diaphragm in chamber E, the diaphragm 5 deflects towards the vacuum port until the disc valve is resting on its seat 1. This prevents further admission of vacuum. If the driver deflects the brake pedal further, the vacuum supply from the master servo to the diaphragm 7 is increased, and the disc valve opens until the vacuum in the front wheel cylinders is again proportional to that in the master servo.

If the brakes are partially released, the vacuum in chamber E is decreased, so the diaphragm and cage assembly moves to the left. This lifts the disc valve off the atmospheric valve seat 3, so that air is admitted through the port B and the holes in the cage to chamber F. When the vacuum in the front wheel cylinders has fallen in proportion to the reduced effort of the brake pedal, the disc once again contacts the seat of the atmospheric valve 3.

As soon as the load on the brake pedal is completely

released, the port D and chamber E are connected, through the distributor valve of the master servo, to atmosphere. This causes the diaphragm and cage assembly to move to the left under the action of the spring 6; the atmospheric valve 3 is thus opened and air is admitted through the port B and the holes in the cage to the chamber F and the front wheel cylinders. Thus, the brakes are released.

From the foregoing description, it can be seen that the degree of vacuum in the front wheel cylinders is always proportional to the vacuum output from the master servo. The ratio between these two vacuum levels is determined by the relative areas of the two diaphragms. In the particular valve described, the larger diaphragm is subjected to the vacuum from the master servo, so the degree of vacuum supplied to the front wheel cylinders is greater than that in the control line from the master servo. In this valve, the ratio of the areas of the two diaphragms is such that, for an input vacuum of 16in of mercury from the master servo, an output vacuum of 21in of mercury is obtained at the front wheel cylinders.

The new vacuum relay valve can be employed with advantage for the remote control of any units where it is required to advance the operation to counteract the inherent lag associated with vacuum systems in general. In this way, the slave units can be made more sensitive to the operation of the master servo. The important advantage of the system, of course, is that, irrespective of whether a supplementary reservoir is used, the air from the slave servos is drawn directly into the reservoir, instead of having to pass over the long distance through the master servo to the reservoir.

Recent Foreign Publications

Brief Reviews of Current Technical Books

Fahrzeugtechnik. Anpassung des Fahrzeugs an den Menschen (Vehicle Engineering. The Fitting of Vehicles to the Human Being) VDI Berichte, Vol. 25

In German.

Düsseldorf: VDI-Verlag G.m.b.H. 1957. 11¾ × 8¼. 102 pp. Price DM 20.80.

This volume is a report on the convention held in Nuremberg on the 28th and 29th March, 1957. It contains ten papers, together with the discussions, which cover various aspects of this important though neglected subject.

The first paper, by Dr. Meyer-Delius, deals with the effect of noise on man. After a general introduction discussing human sensitivity to noise, as established by Bekesy, and Fletcher and Munson, the author deals with the psychological aspect of the noise problem and also the effect of traffic noise on man, in terms of, for example, blood vessel distension and pulse frequency. The paper concludes with a brief review on the effect of noise upon health.

In the second paper, Dr. Stadie describes new developments in silencers, with particular reference to those used with motor cycles and motor rollers. The Frankfurt Pot design, by Dr. Leistritz, and a design by Kuske are described in some detail and the results of noise measurements are given. This paper concludes with a discussion of the factors relating to power losses due to silencers.

The technique of noise measurement is dealt with in the paper by Dr. Martin. That he devotes considerable space to the motor cycle aspect of the problem is not surprising in view of the stringent German and Swiss specifications to meet the legal requirements relating to the maximum permissible noise level of vehicles of this type. The author suggests that curves of noise emission plotted against speed, both with the engine idling and flat out, should be made available to the purchaser. An interesting apparatus developed for the German Transport Ministry is the noise barometer, which consists of a scale about 12 ft high, fitted to the rear of the barometer vehicle. This vehicle is intended to be parked at the side of the road, with a microphone placed some 20 to 40 yards ahead of it, to pick up the noise of passing vehicles. Lamps on the barometer board indicate the noise level to the drivers of the passing vehicles, the object being to encourage drivers of noisy vehicles to take steps to keep them quieter.

The effect of mechanical vibrations on man are dealt with, on the basis of extensive and comprehensive tests, in a thorough and thought-provoking manner by Dr. Dieckmann. This author puts forward a new scale of vibration intensity values plotted as a function of frequency and amplitude or velocity and amplitude. Because of its clarity, this scale is particularly attractive. Results of tests carried out to determine the natural frequencies of passengers, and other results of tests on buses, as well as a discussion of the considerations relating to the combined seat-man system, are particularly interesting and are recommended for careful study by vehicle designers and research workers in this field.

Orthopaedic considerations relating to seat design are considered by Prof. Thomsen, who stresses the importance of the problem. Modern man walks and runs too little and stands and sits too much; this is causing considerable concern to doctors and biologists, because of its adverse effects. Therefore, scientific design of car seats is of great importance. This paper is devoted to an explanation of the function of the relevant bones and muscles. It also deals with the other factors, starting with the properties of the human body, which must be considered in the evolution of rational seat designs.

A brief paper by Dr. Isendahl gives the results of tests carried out to determine the vibrational characteristics of tractor seats. The accelerometers used were fitted to the seat, as well as strapped to the driver. Working conditions in the driver's cab are considered in commendable detail by Dr. Dupuis, who rightly points out the importance of a careful control layout and its effect on fatigue and accident rate. Results of tests carried out to ascertain optimum arrangements of levers, pedals and steering wheel are considered in some detail.

One of the longest papers is by O. Toppe, on the design features that can either cause accidents or render them severe. This author discusses the undesirable features that are sometimes introduced in the design of exterior fittings such as door handles, mirrors, hub caps, sharp extending fins, and filler cap embellishments, all of which can cause considerable harm in car accidents. He also deals with the shape and position of internal fixtures, such as coat hooks, fire extinguishers, window handles and charming accessories such as that which he terms the "scull splitter", which is an anti-glare visor fitted horizontally over the windscreen. Ventilation and noise effects are also considered. This paper certainly achieves its aim, in providing food for thought and thus ultimately encouraging better design from the point of view of accident prevention.

There are two more papers in the volume, one by Prof. Hettche and the other by Schumann and Thoenes. Both deal with exhaust gases. The first discusses the effect of exhaust gases on the human beings and their surroundings, that is, the effect with regard to both the possible promotion of cancer and the cause of smog. The composition of smog and its effect on plant life are also considered. In the second paper, the possibilities of using catalysts or catalytic after-burning, to reduce the adverse effects of exhaust gases, are discussed. In this volume, the high standards of previous VDI reports in this field are maintained. The work can be thoroughly recommended to design and research workers interested in improvements in the performance of road vehicles, so far as noise is concerned.

Vergleich Zwischen Benzpyrengehalt und Rauchdichte bie Zweitakt und Viertakt-Dieselmotoren (Comparison between Benzpyrene Content and Smoke Density of Two- and Four-stroke Diesel Engines). Deutsche Kraftfahrtforschung No. 103

In German. By Richard Marterstock, Dipl. Ing. and Dr. Albert Reuter.

Düsseldorf: VDI-Verlag G.m.b.H. 1957. 11¾ × 8¼. 10 pp. Price DM 7.90.

Emission of cancerogenic substances that could be present in diesel engine exhaust gases has been investigated for engines incorporating various designs of combustion chamber. Results of tests show that the amount of 3·4 benzpyrene emitted is below the detectable limit and there is no relationship between the content of benzpyrene and the smoke density. In view of the importance attached to this particular aspect of engine operation, this brief report can be recommended to all concerned with the subject.

FASTER GEAR FINISHING

Automatic Loading and Unloading Equipment Increases Production Rate on Michigan Gear-Shaving Machines

FASTER and more economical finishing of geared shafts is made possible with new automatic parts-loading and unloading devices developed by Michigan Tool Company, Detroit, 12, Michigan, U.S.A. Although independently operated, both devices are designed to work as a unit with any of the range of Michigan universal rotary gear-finishing machines. The equipment can be supplied as original machine tooling or as a modification unit for all 870-series finishers now in use. In one automotive application on the rear sun gear of an automatic transmission, the devices boosted output of an 870-A gear finisher to 120 parts per hour, at 80 per cent efficiency.

Simplicity, speed and positive positioning are features of the loading unit. Parts are manually stockpiled in the loader to allow one operator easily to handle a battery of machines. All other operations, loading, shaving and unloading, are entirely automatic. Fully automatic feeding devices can, without difficulty, be integrated to the loader to obtain a production rate of 150 parts an hour, if desired.

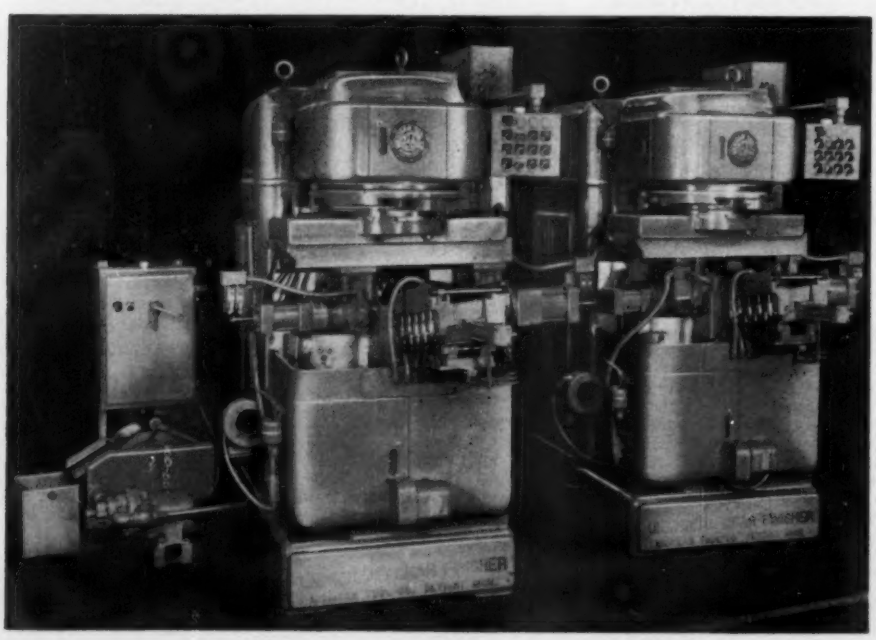
Both the loading and unloading units, although adapted to a specific application, can be supplied to accept various shaft lengths in a wide range of parts. In operation, the geared shafts are manually placed against air-operated escapement fingers mounted on both sides of a gravity chute. A bank of five air cylinders on each side of the loading fixture actuates these escapement fingers, providing a positive, one piece at a time, flow of parts to the loading shuttle.

As each part is released from the last slide position it rolls through a curved, opensided track to the loading shuttle, which has two arms, one to cradle each shaft end. This shuttle is operated pneumatically by a 2½ in bore × 5¾ in stroke cylinder, and will accept one part only at a time. The shuttle arms carry the gear to the shaving position, where it is picked up by air-operated centres. To prevent misalignment of the part, the centres are independently actuated. The tailstock, moved by a 6 in cylinder, advances first and bottoms the part, then the headstock, operated by a 4 in cylinder, moves in to complete the loading action with the gear in mesh with the finishing cutter.

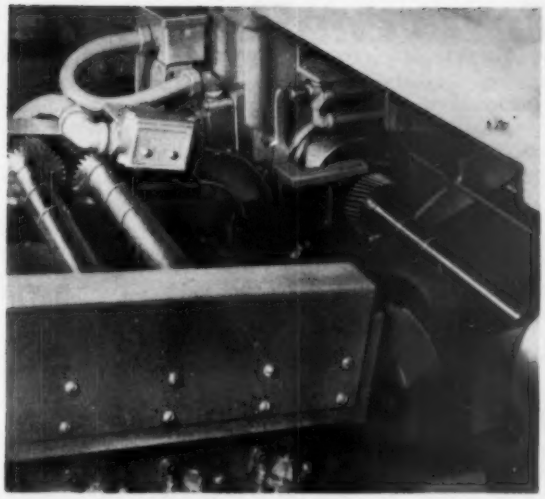
The loading is claimed to be foolproof, for if the part is not meshing properly with the cutter, a limit-switch controlled sensing device prevents cutting action and automatically unloads the part. The unfinished gear is then rejected at the next operation, a checking stage. Improper meshing of the part and cutter is rare, and the device merely insures against any possible cutter damage. After the part is loaded and before the gear is shaved, the shuttle is returned to its normal "load" position. All movements of the loader are interlocked with the machine cycle. If no parts are in position ready for loading, the machine automatically shuts itself off.

After finishing, two arms of the unloader come up and cradle the part as the centres are withdrawn. The unloader arms continue this upward movement to an angle sufficient to cause the part to roll to a stop position on the arms in closer proximity to the unloading conveyor. On the downward return movement of the arms the shaft is caught by outrigged side rails of the conveyor as the pick-up arms continue to their normal position. The part is then in position to be moved by the conveyor. Drive of the chain conveyor is by a 2 in bore × 3¼ in stroke air cylinder. This same cylinder also moves the pick-up arms and indexes the conveyor. Indexing is effected on both the forward and return strokes of the cylinder.

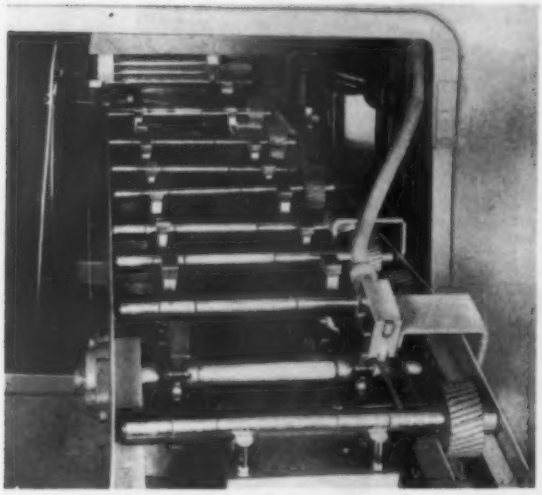
As the parts leave the unloader they pass through a discharge unit that permits the release of only one part at a time. The unloader can be manually cycled "empty", even with the gear finishing machine shut off. Each cycle



Automatic loading and unloading devices for gear finishing machines enable one operator to tend a battery of machines. The units shown are designed to handle geared shafts and are manually fed. Both devices can be supplied as original equipment or as modification units for existing Michigan 870-series gear finishers



The loading device on a Michigan 870-A gear finisher. The unit, adaptable to a wide range of geared shafts, automatically shuttles one part at a time to air-operated centres



The loader removes the part from the work position and transfers it to the chain-driven conveyor for movement to the next operation. The device can be independently emptied

function is interlocked electrically to maintain correct sequence, whether on manual or automatic cycle.

These new automatic loading and unloading devices, are timed to suit the cycle of a particular application, but are fast enough in actuation to meet the demands of any gear finishing operation on parts having shafts. They are designed for easy integration with Gear-O-Mation parts-handling and distribution systems and present few maintenance problems.

Michigan machines and equipment are factored by Gaston E. Marbaix Ltd., Devonshire House, Vicarage Crescent, London, S.W.11.

Self-Adhesive Nameplates

MODERN methods of production, distribution, spares organization, and marketing call for a simple and permanent method of identification for both component articles and complete units. In addition to the ordinary nameplate there are required plates for specifications, data, instructions, dials, scales, and control indications. It is economically essential that such items are of low cost, can be easily and securely attached to the component, and retain their legibility throughout the serviceable life of the component.

This need for durability makes the metal plate an obvious choice for engineering components, but various plastic materials are now being extensively used. Methods of marking the plates differ widely. They may be cast, embossed, chemically engraved, double anodized, or printed to suit specific applications. Any colour or finish can be provided.

For long the only means of attachment was mechanical, by rivets or screws. This method had several disadvantages. It tended to increase the size of the plate, the heads of the screws or rivets detracted from the appearance or the legibility of the message, the hazard of damage to the plate or to the finish of the component by the fixing tool was always present, and it was costly and time-wasting. Commonly, the cost of fixing was greater than the cost of the nameplate. Adhesives were used, but generally these required heat or pressure, or both heat and pressure, to obtain a secure bond. Plates coated with a self-adhesive composition needed the application of an activising solvent.

A new type of self-adhesive plate has now been developed by Millet, Levens Ltd., Stirling Corner, Barnet By-Pass, Borehamwood, Herts. With these it is necessary merely to immerse the plate in water, preferably warm water, for a few seconds and then slide off the protective film. It is then ready for application and, solely by firm pressure, will adhere to practically any surface that is clean and free from dust.

All types of metal and plastic plates can be supplied with the new adhesive. They can be fixed to parts and in locations previously regarded as inaccessible. As regards the permanence of the bond, the illustration shows that it has been found satisfactory even for production tools in the workshop.

A Millett Levens self-adhesive, anodized nameplate affixed to a machine vice manufactured by Jones and Shipman Ltd.

Intercooling and Turbocharging

An Account of Development Work Done by B.S.A with a View to Improving Engine Torque Characteristics and General Performance

IN the October 1957 issue of *Automobile Engineer*, the B.S.A. turbocharger was described and a number of important aspects of its development and production discussed. Since then, all the major engine manufacturers in this country have become interested in this unit, as also have some of the larger operators of public service vehicles. One of the municipal operating companies states that their average fuel saving, as indicated by extensive service tests of vehicles equipped with the turbocharger, has been 8½ per cent; however, B.S.A. have not yet had time to confirm these results.

Since the B.S.A. turbocharger was described in *Automobile Engineer*, intensive development work has continued. One of the latest advances is the design of an intercooler arrangement for use in conjunction with the turbocharger. This development arose from the following considerations. For some time, many engine manufacturers have been investigating the possibility of adopting pressure ratios of the order of 3:1. They are not seeking to use these high ratios to improve the performance at the upper end of the speed range, but rather is the aim at good torque at the lower end. In this connection, B.S.A. feel that the employment of an intercooler will probably give more satisfactory overall results. At low engine speeds, the increased density of charge obtained by intercooling improves the torque characteristics, but as the speed, and therefore the rate of air consumption, is increased, the effectiveness of the intercooler falls off because the advantages gained by cooling the charge becomes increasingly offset by the greater resistance that the intercooler offers to the air flow.

The employment of an intercooler can be justified on the

This view of part of the machine shop used entirely for turbocharger development demonstrates the magnitude of the resources devoted to this project

following grounds. If a pressure ratio of, for example, 1·5:1 is adopted, the density ratio obtained without an intercooler is generally in the order of only about 1·3:1; this is because of the rise of air temperature across the turbocharger. In these circumstances, the volume of air required for combustion is 15 per cent greater than it would be if there were no rise in temperature between the air intake and the engine. When an intercooler is used, this rise in temperature is, of course, reduced.

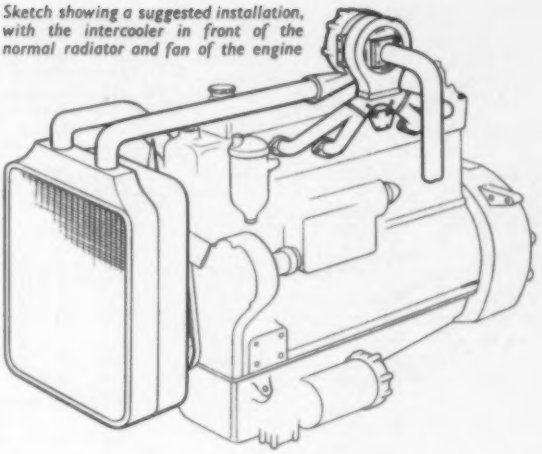
There are three other advantages to be gained by intercooling. One is that the increased air supply, particularly at low engine speeds and high outputs, gives a more satisfactory air:fuel ratio and therefore reduces the tendency to exhaust smoke. Secondly, the increased mass-flow of air reduces the operating temperatures of the pistons and valves. Thirdly, the fact that the incoming air is cooler also helps to reduce these operating temperatures.

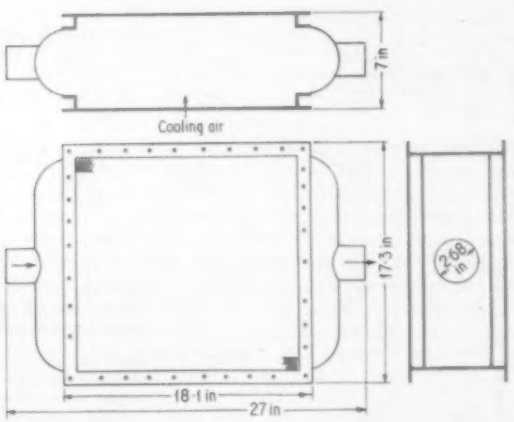
At an early stage in the development work, B.S.A. decided that the air-to-air type of intercooler is the most suitable for adaption to automotive use. If water is used for the cooling medium, the heat transfer has to take place first from the air output of the turbocharger to the water, and then from the water to the ambient air. This method is therefore less direct than the air-to-air method of intercooling. Another disadvantage of the air-to-water type of cooler is that special provision has to be made in the radiator to maintain, at an adequately low temperature, the portion of it that serves the intercooler.

The intercooler

The general arrangement of the intercooler can be seen from the accompanying illustrations. This unit was designed primarily for development with a 9·6 litre engine, but the size of the matrix is such that it could be incorporated in most engine installations. It is thought that the best position for the matrix would be in front of the engine radiator. In the unit illustrated, the shape of the inlet and outlet manifolds was determined by the need to keep the overall width to a minimum. Better induction flow rates could be obtained in

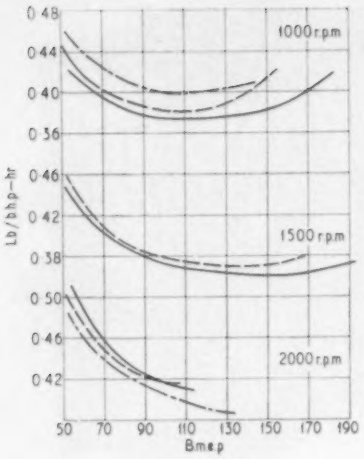
Sketch showing a suggested installation, with the intercooler in front of the normal radiator and fan of the engine





Above: Layout of the intercooler used for development work by B.S.A.

Below: A view of another part of the machine shop shown opposite



Left: Curves showing the effects of intercooling on engine fuel consumption

- - - - - Not intercooled, injection 26 deg B.T.D.C.

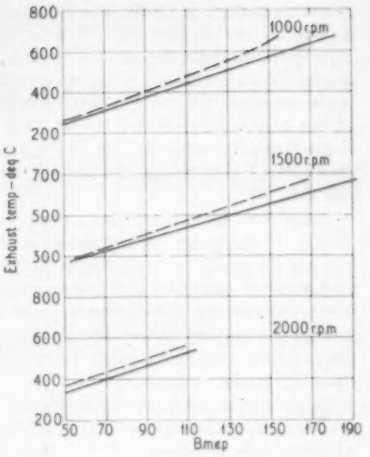
——— Air-to-air intercooler, injection 26 deg B.T.D.C.

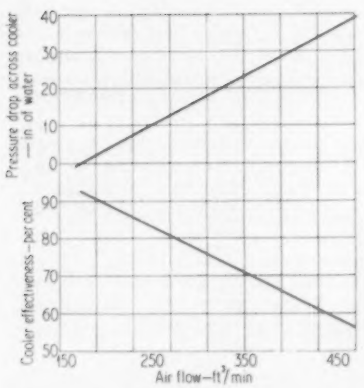
— — — Air-to-air intercooler, injection 34 deg B.T.D.C.

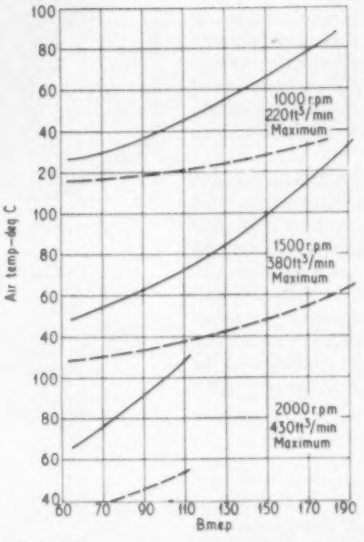
Right: These curves show the effects of intercooling on exhaust temperature

- - - - - Not intercooled

——— Intercooled







Left: The lower of these two curves shows the effectiveness of the cooler and the upper the induction system pressure drop across the unit

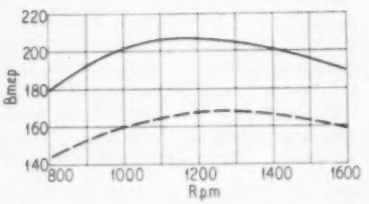
Right: By employing an intercooler, the peak of the torque curve is moved lower down the engine speed range and an appreciably higher b.m.e.p. is obtained throughout the range

- - - - - - - Not intercooled ——— Intercooled

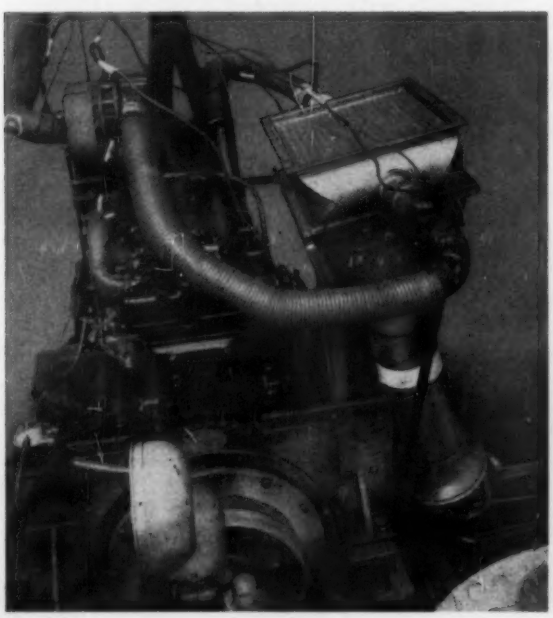
Left: Results of tests that were made to determine the air temperatures in the cooler inlet and outlet at three different engine speeds. The maximum temperature drop across the cooler is 70 deg C at 190 b.m.e.p. and an engine speed of 1,500 r.p.m.

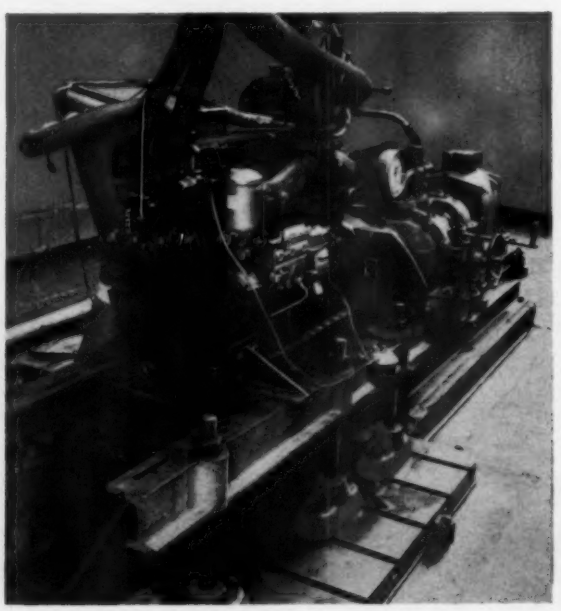
- - - - - - Induction air temperature at cooler inlet

——— Induction air temperature at cooler outlet



Below: Two views of the 9·6 litre engine on its test bed, with the Marston Excelsior intercooler installation used for development work. Air is drawn through the intercooler by a ½ h.p. motor-driven fan assembly, the lower end of which can just be seen at the base of the funnel-shaped duct





some installations where adequate space is available for larger manifolds. The coolant flow for which the intercooler was designed is 1,500 ft³/min. This quantity of air can be supplied by a fan absorbing between 1 and 2 h.p.

For the development tests described in this article, the cooling air was ducted to the matrix from a fan driven by a ½ h.p. motor, which is suitable for flows of up to 250 ft³/min. Had a larger motor, for example, a 2 h.p. unit, been used, the dimensions of the intercooler could have been reduced. However, this was not felt to be necessary, in view of the fact that the intercooler would probably be required to be of the same overall dimensions as the engine radiator.

Cooler performance

Results of tests made to determine the air temperature at the cooler inlet and outlet for three engine speeds, namely 1,000, 1,500 and 2,000 r.p.m., are given in an accompanying illustration. These results show that the maximum temperature drop across the cooler is 70 deg C at 190 b.m.e.p. and 1,500 r.p.m. Under these conditions, the maximum flow, corrected to atmospheric density, is 380 ft³/min. The curves obtained at 2,000 r.p.m. were not taken above 110 b.m.e.p. because of limitations with respect to turbocharger speed.

Another illustration shows the cooler effectiveness and the pressure drop across the unit, both being plotted against air flow in ft³/min. The range of air flow covered is typical of that generally experienced with commercial vehicle diesel engines in normal operation. Although the pressure differential across the cooler is fairly high, this is understandable since the unit was designed for a flow of only 250 ft³/min, which is adequate to give the required torque characteristics. At this latter rate of flow, the pressure drop across the cooler is 10 in of water, and presumably most of this loss is due to the shape of the inlet and outlet manifolds. The curve of cooler effectiveness is obtained from the following formula:

$$\frac{T_I - T_O}{T_O - T_A}$$

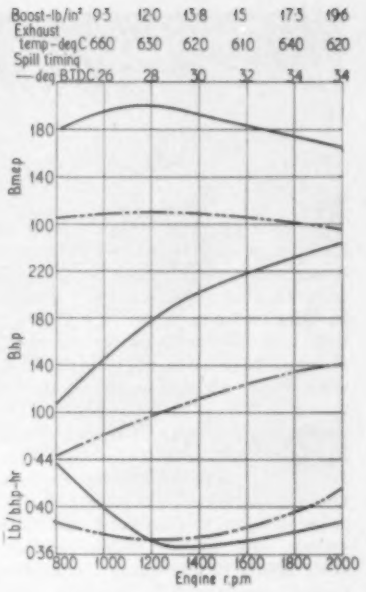
where T_I is the cooler inlet temperature, T_O the cooler outlet temperature and T_A the cooling air inlet temperature. From the curve, it can be seen that up to the design flow, the effectiveness of the cooler is above 80 per cent.

One set of curves illustrated shows the effects of the turbocharger and intercooler on the fuel consumption of a 9·6 litre engine. From these curves it can be seen that, for example, at 1,000 r.p.m., and a brake specific fuel consumption of 0·40 lb/b.h.p-hr, an engine equipped with a turbocharger and an intercooler will develop 170 b.m.e.p. as compared with 140 b.m.e.p. obtained without the intercooler. A similar gain can be obtained at 1,500 r.p.m. If an automatic injection advance and retard mechanism, controlled by engine speed, is fitted, performance can be even further improved, as can be seen by comparing the curves obtained when the injection is timed at 26 deg B.T.D.C. with those obtained when it is timed at 34 deg B.T.D.C. At low engine speeds, the best results, of course, are experienced when the injection timing is retarded, and at high speeds it should be advanced. There are two more sets of curves, one showing the effect of intercooling on exhaust temperature and the other comparing the performance of a naturally aspirated 9·6 litre engine with that of the same engine equipped with the B.S.A. turbocharger and the intercooler. Yet another illustration, on the opposite page, compares the torque outputs of a turbocharged 9·6 litre engine with and without an intercooler.

Curves showing the performance of a 9·6 litre engine in the naturally aspirated condition and with the B.S.A. turbo-charger and air-to-air intercooler

– – – – – – – *Naturally aspirated*

——— *Turbocharged and intercooled*



Conclusions

Although the intercooler described is only an experimental unit, designed so that it can be modified to suit various installations it has been demonstrated that even with a fan absorbing only a relatively small power, a considerable increase in engine output can be obtained. If a larger fan were fitted, the effectiveness of the cooler at higher rates of flow would be improved. Vehicle manufacturers' preferences and individual applications will have to be considered before a standard intercooler design can be developed. Providing the cost of the intercooler can be kept to a figure of approximately £10 to £15, the addition of the unit to the installation will be worth while not only because it improves the torque characteristics and power output, but also because it leads to marked economy in fuel consumption during normal operation.

MATERIALS HANDLING

THE 1958 Mechanical Handling Exhibition and Materials Handling Convention will be held at Earls Court from 7th to 17th May. For the first time, the Exhibition will be international in character, with over 250 exhibitors from Great Britain, France, America, Germany, Italy and Scandinavia displaying thousands of cost and time-saving devices. There is today a very keen realization of the importance of materials handling as a cost factor, and the application of the best methods is fundamental to industrial efficiency. Every other year, this Exhibition provides a unique opportunity for examining all the latest developments over the whole field of materials handling.

Concurrently with the Exhibition, which is organized by our associate journal *Mechanical Handling*, there will be a Materials Handling Convention at which papers on a wide variety of subjects will be presented by acknowledged experts.

Admission tickets may be obtained by application to H. A. Collman, "Mechanical Handling," Dorset House, Stamford Street, London, S.E.1.

Composite Springing

The Incorporation of Aeon Hollow Rubber Springs in Conventional Suspension Systems

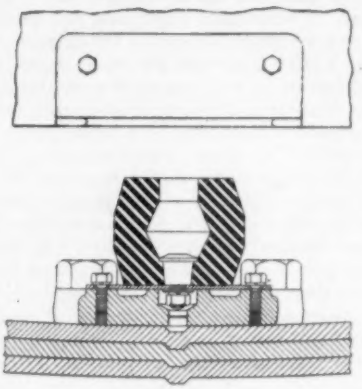
WHEN the Aeon hollow rubber spring was introduced a few years ago,* it was widely regarded merely as a helper spring to supplement and safeguard an existing suspension system against overloading and adverse operating conditions. In obvious cases, where vehicles such as newspaper vans, ballast trucks and brick lorries were regularly engaged on alternate fully laden and completely unladen journeys, they were readily adopted and performed satisfactorily to reduce spring fractures, to permit the raising of the speed when unladen, and to reduce vehicle maintenance costs. However, it was not fully appreciated that they could be utilized, in conjunction with orthodox leaf springs, to provide a smoothly variable suspension rate at low cost and without complication.

In addition to increasing the maximum capacity of the system, the steeply rising load-deflection characteristic of the hollow rubber spring in compression offers the designer further opportunity to improve vehicle performance or to reduce production and maintenance costs, or both. Probably the most important of these supplementary advantages is the reduction of unsprung weight. When Aeon rubber springs are fitted they are mounted to come into action at from 50 per cent to 66 per cent of maximum load. Steel springs of lower rate can be used, giving a softer ride under no-load or low-load condition, and this is commonly effected by reducing the number of leaves in the springs.

If the rubber springs are used on both front and rear axles a saving of up to 200 lb can be made in the unsprung weight on a coach or a truck. Even on a rear axle only, the replacement of the normal helper springs on a truck by hollow rubber springs can yield a saving of weight of 100 lb and give improved capacity and, when unladen, a better ride. Composite springing, giving a progressive rate can be designed at less than 66 per cent of the weight of a conventional leaf spring suspension of single-rate characteristic.

One interesting suspension system designed by a Finnish manufacturer, currently undergoing test and development, employs only five leaves in the steel springs, which are each supplemented by five Aeon rubber springs. The total spring weight has by this means been reduced by more than 50 per cent.

Although low-rate steel springs may be fitted, any tendency of the vehicle to sway or to roll when cornering will be effectively resisted by the rubber springs. The need for an anti-roll torsion bar, in most instances, completely disappears. In this connection they have been proved to be of the greatest value in combating sway on double-decked buses and on transport vehicles carrying high and top-heavy loads. Two provincial municipal bus companies, both operating double-deckers, may be cited by way of example. After fitting Aeon springs to their vehicles, one concern discarded the anti-roll bars and the other the hydraulic dampers that hitherto had been essential equipment.

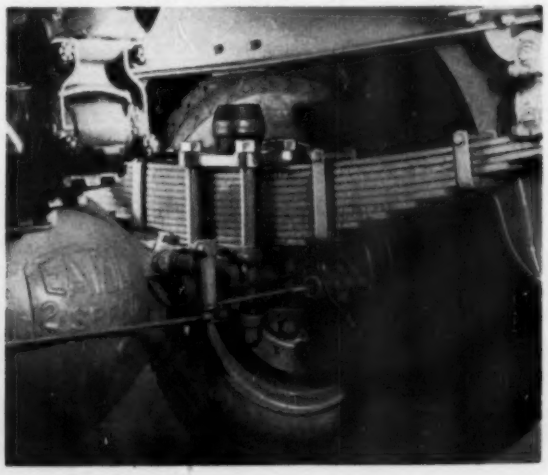


Spring-mounted Aeon rubber spring on E.R.F. Model 44G, 13 tons gross, four-wheeler

*"Automobile Engineer," October, 1954.

Type 550/65 high-deflection spring on Commer TS3 L.W.B. 7-tonner front axle (Hovis Ltd.)

Barrel springs, Type 103, are fitted to the rear axle of the E.R.F. Model 44G end tipper



High-deflection rubber spring for front axle of Atkinson Model L.946L, 9-tonner

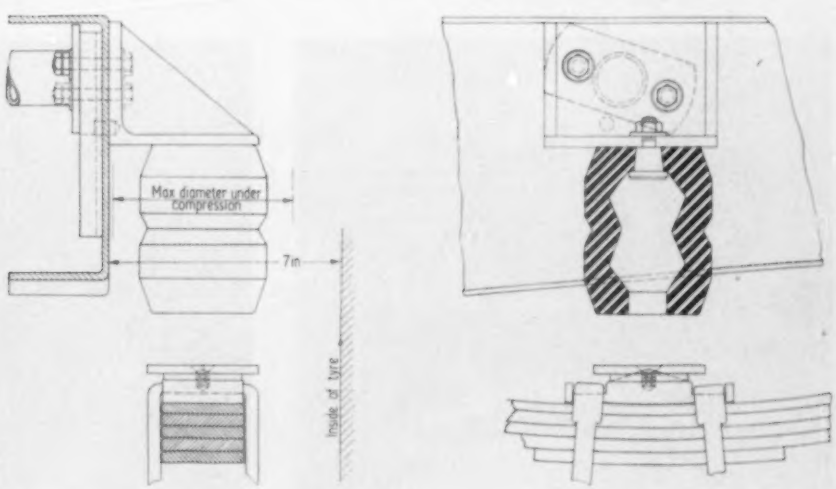
Flange reinforcement of side frame for rubber spring mount for Atkinson 9-tonner rear axle

In similar manner, they have been fitted to tippers, concrete tankers, dumpers, and mobile cranes to minimize sway while travelling and also tilt when stationary. In many applications the usual stabilizing jacks can be dispensed with, thus effecting savings in first cost, weight, and operating time. An example in point is a Smith 15-ton crane mounted on a Foden chassis. With the standard suspension it was possible to make a front lift over the vehicle cab of only 6-7 tons but when equipped with Aeon springs to supplement the steel springs, front lifts of 13-14 tons were practical.

The rubber spring has an inherent damping characteristic, as is shown in the load-deflection curves. This functions to lessen the work to be done by hydraulic dampers and reduces what, under arduous operating conditions, is liable to involve relatively costly and time-absorbing maintenance operations. The experience of a public works contractor, operating a large fleet of dump vehicles under strenuous conditions on an exposed site, is of some interest. In order to keep the vehicles in service it was found necessary, as a routine measure, to remove the hydraulic dampers for re-servicing or complete replacement after every 2,000 miles operation. When Aeon rubber springs were fitted to the suspension, the hydraulic dampers were discarded.

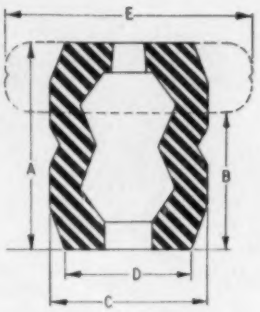
It was mentioned earlier that the rubber springs are commonly mounted to come into action at some specific loading. This implies that the spring is located at some distance from its abutment when the unladen vehicle is static. In the case of vehicles likely to be engaged on duties in which a large proportion of their running time will be while unladen or only very lightly laden, however, the springs may be slightly pre-stressed in the static unladen condition. As a consequence, such phenomena as vehicle bounce, wheel hop and spring flutter when running light can be materially reduced or even eliminated. On articulated vehicles, the provision of suitably pre-stressed rubber springs on the tractor rear axle can cut out chatter at the fifth wheel when running unladen.

The location of the rubber spring in relation to the axle may be of some importance on specific vehicles. Normally they are arranged directly above the axle but by mounting a short distance to the rear of the axle they can be utilized to resist "wind-up" under braking torque and this reduces the



Arrangement of Aeon Type 535/65 springs on Thames Trader 5-tonner rear axle, by Dagenham Motors Ltd.

DIMENSIONS AND CAPACITIES OF STANDARD AEON SPRINGS



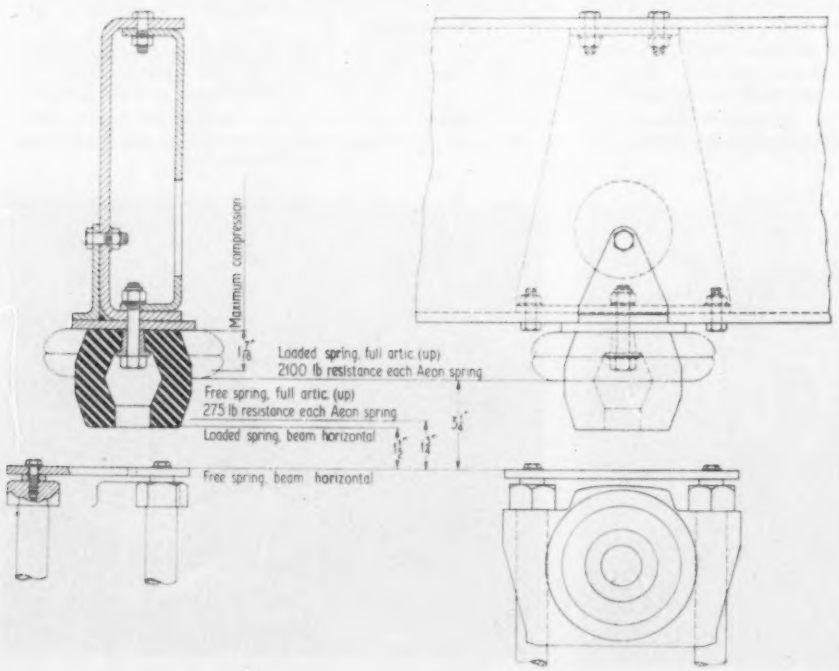
Type	Shore deg	Max. capacity lb	A Free height in	B Max. deflect. in	C Outer dia. in	D Face dia. in	E Max. dia. deflect. in
505	55	290	3⅛	1⅜	2½	1⅛	3⅛
505	65	290	3½	1⅛	2½	1⅛	3
515	55	770	3⅞	2	3⅛	2½	4½
515	65	990	3⅞	2	3⅛	2½	4½
520	55	880	4	2⅛	2⅛	2	3½
520	65	1540	4	2⅛	2⅛	2	3½
530S	55	1800	4⅛	2⅞	3⅛	2⅛	4⅞
530S	65	2200	4⅛	2⅛	3⅛	2⅛	4⅛
535	55	3750	5⅛	3⅛	4	3⅛	5⅛
535	65	6600	5⅛	3⅛	4	3⅛	5⅛
540	55	7200	5½	3⅛	4⅛	3⅛	6⅛
540	65	7700	5½	3⅛	4⅛	3⅛	5⅛
550	65	5000	3½	2⅛	3½	2 7/16	5½
560	65	5500	8½	6	6	4	8½
55/55	55	330	2½	1½	2½	1⅛	2⅛
103B	55	4000	3½	2	4½	3½	5⅛
103B	65	5400	3½	1⅞	4½	3½	5⅛

The three springs listed at the foot of the table are of the barrel type.

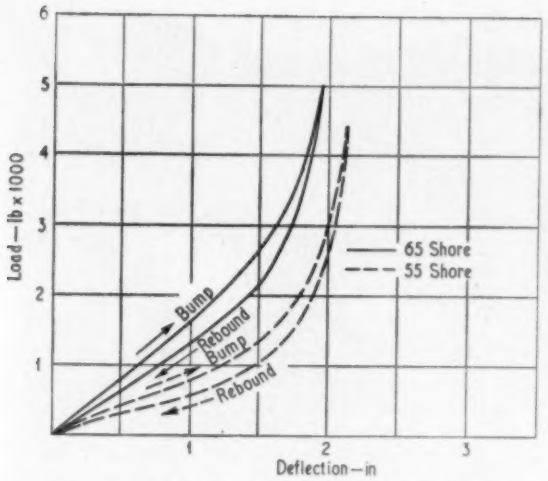
stressing of the steel springs. On some vehicles, particularly those of forward-control type, the steering is prone to become relatively heavy as the tyres wear and the tread flattens. By fitting Aeon springs slightly to the rear of the front axle the effect of load transfer is resisted on the over-run or when cornering, and the trailing angle of the wheels is held closer to the designed normal than would otherwise obtain. As a consequence the self-centering characteristic is sensibly maintained and the vehicle comes out of the turn without requiring appreciably greater effort. At least two municipal passenger transport services have successfully adopted this method of mounting on double-decked buses in order to meet complaints of fatigue from their driving staffs.

The standard range of hollow rubber springs produced by Aeon Products (London) Ltd., 16 North End Road, London, N.W.11, includes units having maximum load capacities of from 290 lb to 7,700 lb and maximum deflections of from 1½ in to 6 in. Each size of spring is available moulded in rubber processed to alternative hardness values of 55 deg or 65 deg Shore, with consequent different operating characteristics. The material used is first-quality Malayan plantation rubber having specially high tensile properties, and no reinforcing material is needed in the mouldings. Both in this country—British Specification No. 755185—and abroad, the design in conjunction with the selected rubber properties, form the subject of Letters Patent.

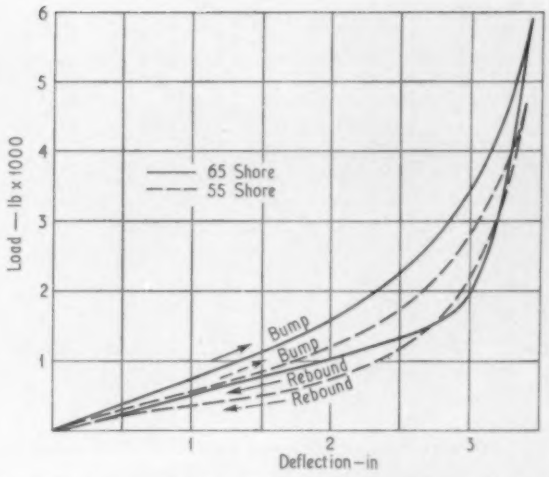
The relative ease with which the rubber springs can be fitted to existing vehicles, involving the minimum constructional modification and the provision of simple brackets, braces, and spring platforms, has facilitated the adoption of composite springing in numerous ancillary fleets operated by manufacturers in various industries and also in private transport fleets. From reference earlier to the application of the springs on double-decked buses, tippers, concrete



Chassis-mounted rubber spring, Type 103B/55, serving as helper spring for the rear bogie of Atkinson six-wheelers and eight-wheelers



Load-deflection curves for Type 103B barrel springs. Static load should not exceed 50 per cent of maximum load



Load-deflection curves for Type 535 high-deflection springs. Static load should not exceed 50 per cent of maximum load

tankers, and dumpers, it might be inferred that they were mainly of use on vehicles of a specialized character or on those operated under adverse conditions or over rough terrain. Such an impression would be quite incorrect. The private transport and ancillary fleets are mostly operated over "A" class roads in Britain.

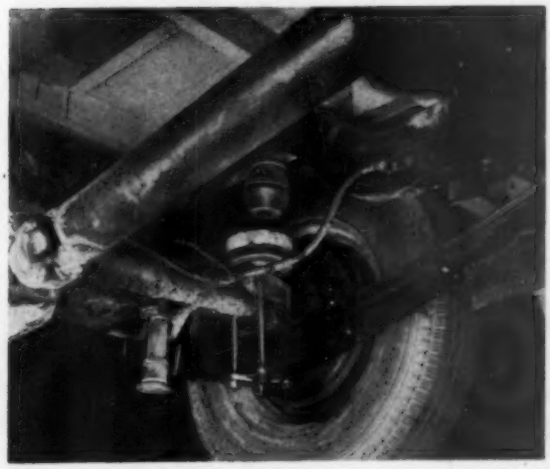
Typical examples of this practice may be quoted. The flour-milling firm of Hovis Ltd., fits Aeon rubber springs to all its Foden eight-wheeled, bulk wheat carriers, to its Leyland Beaver and trailer units, and to all newly acquired Commer 7-tonners. This policy, it is reported, has resulted in improved vehicle utilization and virtual freedom from spring breakages. In the transport contracting field, the firm of N. Francis and Co. Ltd., equips its vehicles, including Fordson 5-tonners, with Aeon rubber springs and has reduced its expenditure on spring replacements by more than 50 per cent.

As might be expected, the advantages to be secured by the combination of hollow rubber springs with the usual steel springs of a conventional suspension system, at low cost and without major design alteration, have not passed unnoticed. A number of vehicle manufacturers are now designing suspension systems to incorporate Aeon rubber springs as standard specification.

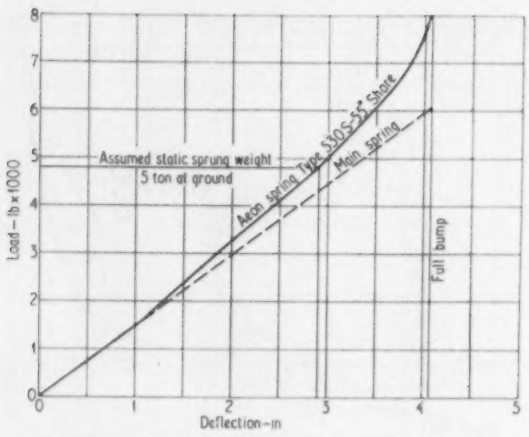
E.R.F. Ltd. has been fitting Aeon rubber springs to a number of its extensive range of vehicles, as standard initial equipment, for the past three years. To date, barrel-shaped springs have been used exclusively. An example is the tipper version of the Model 44G four-wheeler. This is a 13 tons gross vehicle, with a twin-ram hydraulic tipping gear giving the body an end tip of 45 deg. Atkinson Lorries Ltd. fit Type 535/65 and Type 540/65 rubber springs to front and rear axles respectively of the L.946L, 14 tons gross, four-wheeler. These rubber springs are chassis mounted, and the method of bracing the flanges of the channel side frame in way of the rear spring mount will be noted. The bracing is also shown in detail on the layout drawing of the mounting of an Aeon barrel-shaped rubber spring, Type 103B/55, for the rear bogie of Atkinson six-wheelers and eight-wheelers. In this instance the rubber spring is arranged to function as a helper spring, coming into operation at a specific loading.

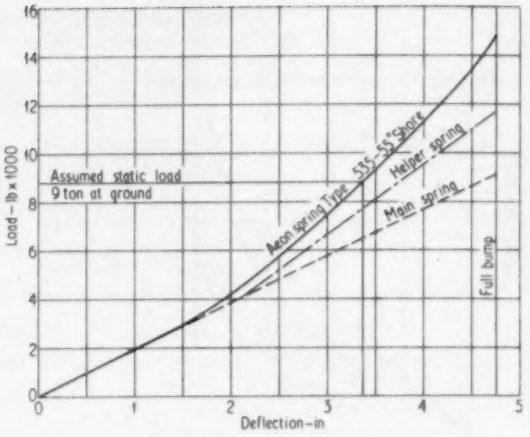
The latest vehicle to be introduced by Seddon Motors Ltd. is fitted all round with Aeon springs. This is the Mark

"Star" newspaper van, Austin taxi chassis, with Type 102A spring for rear axle



Type 104 barrel spring, chassis-mounted for Fordson 5-tonner rear axle (N. Francis and Co. Ltd.)





Composite spring on the Seddon Mark 15/10 14 tons gross vehicle. Load-deflection curves for front axle (left) and rear axle (right)

15/10 four-wheeler, which uses the same basic chassis as the Mark 15 7½-tonner, but can operate at a gross weight of 14 tons. For taxation purposes the chassis weight only slightly exceeds 4 tons and consequently a payload approaching 10 tons can be carried legally. Type 530S/55 springs are fitted at the front and Type 535/55 springs at the rear. An unusual feature is that the normal helper springs have been retained. The chassis is produced with a single, standard wheelbase of 14 ft 6 in, and the overall length is 24 ft 11 in. In order to minimize the possibility of loading the rear axle above the legal maximum of 9 tons, it is recommended that the platform length should not exceed approximately 19 ft.

This vehicle provides an interesting example of the manner in which the suspension on a chassis of established design can readily be modified by the addition of Aeon rubber springs in cases where the static laden weight has been increased beyond the normal design value. Such need may arise if it is desired to increase the payload, or should heavy bodies carrying specialized equipment be fitted.

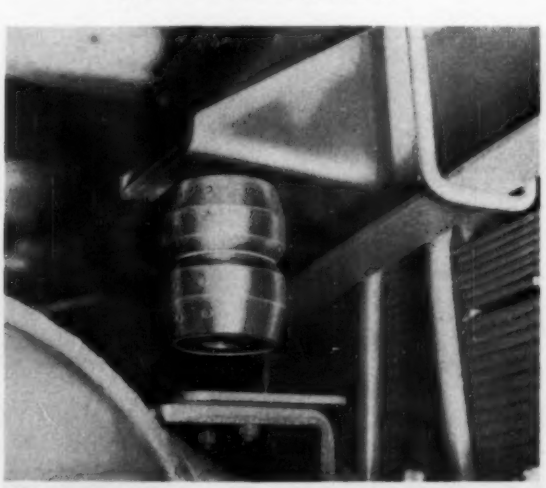
Dagenham Motors Ltd., distributors of Ford vehicles, has standardized an application of Aeon rubber springs to the rear axle of the Thames Trader 5-tonner. In this instance the rubber springs, Type 535/65, are carried on angle brackets outside the side frames. The chassis frame is stiffened locally by a stout transverse stress tube bridging the frame between the mounting brackets. Several other manufacturers install Aeon springs on their vehicles to meet specific requirements. For example, certain Foden tippers are fitted with rubber springs.

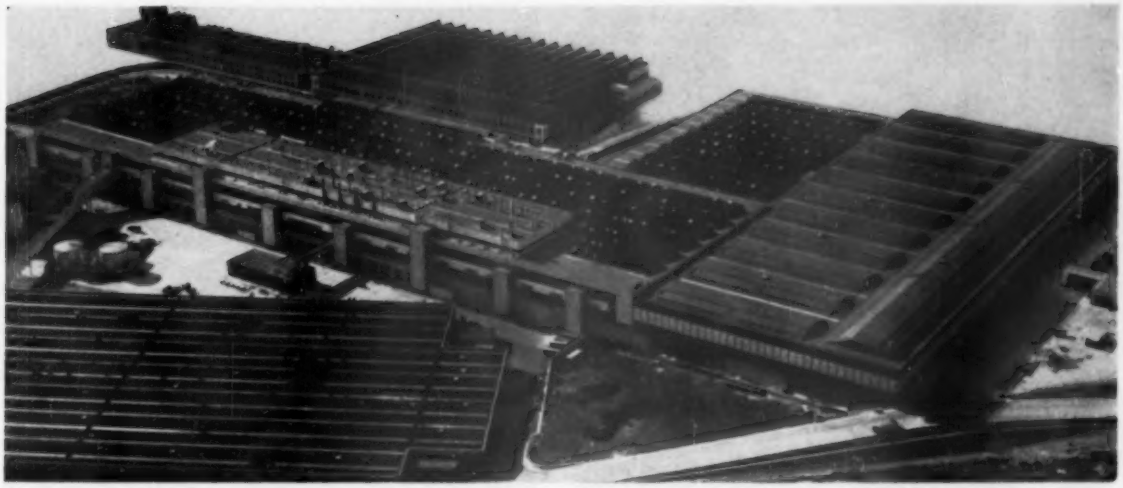
Rubber springs can be mounted either on the chassis frame or on the leaf spring clamping plate, and installation presents little difficulty. Simple, fabricated brackets are bolted, riveted, or welded to the side frames and counter plates are secured to the spring plate, or *vice versa*. It is usual for any attachment to the spring plate to be detachable, in order that the removal of the spring U-bolts is not impeded. In some instances, as in the case of the Thames Trader vehicle equipped by Dagenham Motors Ltd., it may be necessary to machine a face on the spring plate to receive the rubber spring counter plate.

Attachment of the rubber spring is, in all instances, by means of a conical bolt or stud, or a standard bolt and nut in conjunction with a conical sleeve. Stud members may be riveted or welded to mounting brackets or plates, ready for permanent or demountable attachment to the chassis frame. The aperture in the end of the rubber spring can be forced over the head of the stud to take up its position gripping the cored shank. In service, a rubber spring requires no maintenance and its life is virtually unlimited.

Type 530S/55 spring chassis-mounted for front axle of Seddon Mark 15/10 four-wheeler

On the Seddon Mark 15/10 rear axle a Type 535/55 rubber spring supplements main and helper springs





The new passenger car production factory at the Luton works of Vauxhall Motors Ltd.

Production Expansion

Important Developments at the Luton and Dunstable Works of Vauxhall Motors Ltd.

In common with all the other major automobile manufacturers in Great Britain, Vauxhall Motors Ltd. have, since the end of the 1939-45 war, carried out very important projects to expand production and increase productivity. The first major production project undertaken by Vauxhall was the building of a new factory at Luton. This factory, which was ready in 1950, was equipped for machining all mechanical components for Vauxhall passenger cars and Bedford commercial vehicles. Engine assembly for both classes of vehicles and chassis assembly for commercial vehicles were also carried out in the new factory. This development led to a very considerable increase in output.

However, it eventually became apparent that the increase in output, great though it was, did not suffice to meet the demand for Vauxhall vehicles. Further expansion was, therefore, planned and a scheme was given final approval in mid 1954. At that date the yearly productive capacity was in the order of 130,000 passenger cars, light vans and commercial vehicles. The intention of the new scheme was to increase this capacity to 250,000 vehicles.

To effect such an expansion of production it was, of course, necessary to have a greatly increased factory floor area. So far as this factor is concerned, the main features of the scheme have been the construction of a completely new building within the Luton plant to give an additional 1,500,000 square feet, the extension of the Dunstable plant from 120,000 to 1,250,000 square feet and the erection of a new building of 500,000 square feet at Dunstable to house all the Company's parts and accessories activities.

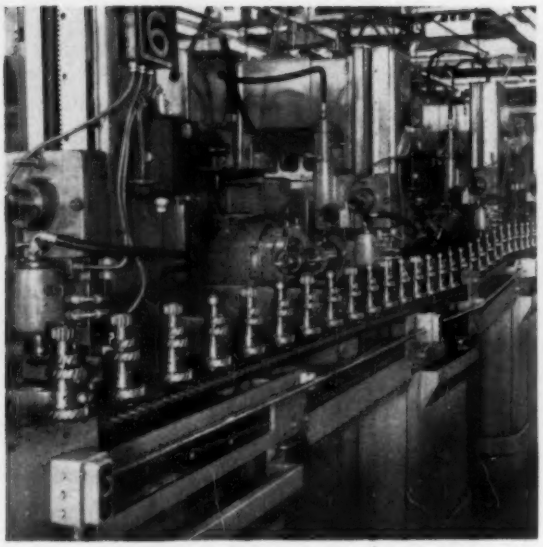
Before this expansion project began, passenger cars and all commercial vehicles were produced at Luton, while the small factory at Dunstable was used only for the manufacture of a limited number of non-current components for spares. To enable a greatly increased scale of passenger car production at Luton, it was necessary to move truck manufacturing operations to a new location. The decision was, therefore, taken to enlarge the Dunstable factory to house all Bedford truck manufacturing and assembly functions to Dunstable, except for the production of the steel cabs, which is still carried out at Luton.

The new factory building at Luton houses a press shop, body building, paint and trim departments and final assembly lines. Machined mechanical components are fed into it by conveyor from other buildings. The Dunstable factory, which is over 2,000 ft long, is believed to be the largest truck manufacturing plant in Europe. In addition to truck manufacture, this factory is also used for the production of spare parts for all non-current Vauxhall and Bedford vehicles.

Other buildings erected at Luton under the expansion project include an extension of the die shop, a boiler and compressor house, a paint mix building, oxygen and acetylene stores and a comprehensive plant for the treatment of trade effluent. At Dunstable, a boiler house, a 500,000 gallon water storage tank, swarf house, paint stores and oil stores have also been completed. Additional office, canteen and surgery facilities have also been provided at both locations.

Although the scale of factory expansion is impressive, much more impressive to engineers will be the fact that a 92 per cent increase in output has been achieved with only a 57 per cent increase in total number of people employed. This is the more noteworthy because even before this project, the equipments and methods employed in the Vauxhall factories were recognized as being of a character that gave very high production efficiency. Incidentally, it may be remarked here that the increase in productivity is even greater than the quoted percentages suggest, since certain manufacturing operations that were not carried out previously are now undertaken. These new departures include the manufacture of valves, the machining of crankshafts and a greatly increased production of chromium plated components.

Briefly, the increase in productivity per man-hour may be ascribed to a greatly extended application of mechanization throughout the production organization. This applies to



A six-station line of Churchill hobbers with a simple form of chain transfer mechanism

Great use is now made of transfer machines. This is a 48-station transfer machine for cylinder blocks

both the actual processing of components through operation sequences and to the transfer of finished parts to other locations. In the metal cutting section for example, far wider use is made of transfer machines than was the case hitherto and, in general, there has been a considerable increase in the number of stations per machine. Advances have also been made in the application of mechanization to press operations. It is not proposed to describe these developments in detail in this article—they will be dealt with in subsequent issues—only a general overall picture of the expansion scheme will be given.

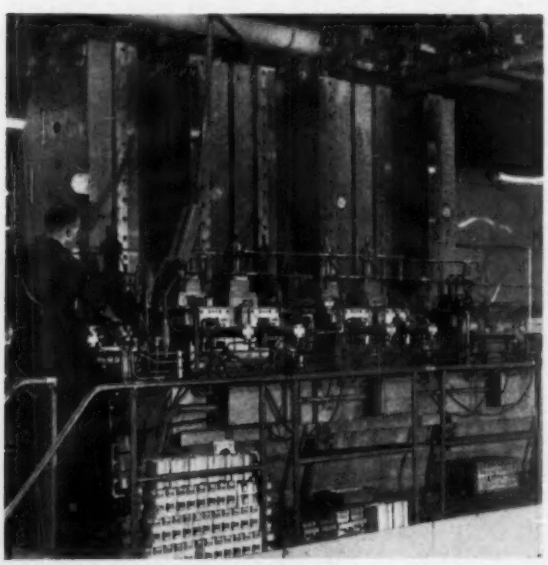
Manufacture of mechanical units

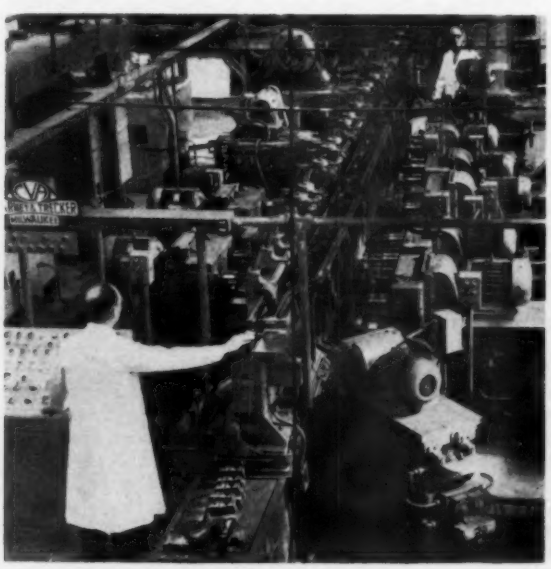
Engine, gear and axle components and their assembly into units is carried out in a 19½ acre building adjacent to the new car production building. In addition to the machining sections, which, where necessary, include heat treatment plants, this building also houses three assembly lines for engine, front axle and rear axle assembly respectively.

A very brief description of the cylinder block line will serve to illustrate the very advanced machining methods that are employed. The line for the actual machining operations on the cylinder block incorporates four transfer machines, three Ingersoll machines with 13, 6 and 19 stations, and a Barnes machine with 48 stations. All have been provided with swarf disposal conveyors that run in channels cut in the floor of the shop beneath the machines. The cylinder block line also includes several multi-head and multi-spindle individual machine tools, automatic washing, pressure testing and inspection devices.

At some stage in the cylinder block machining it is necessary to assemble the main bearing caps to the block. These

All machining operations on the main bearing caps prior to assembly are carried out on these two machines. On the left is a six-station Weatherley Oilgear broaching machine and on the right a Kearney and Trecker 16-station in-line transfer machine





components are produced on two transfer machines adjacent to the block machining line. The first of these two machines is a Weatherley Oilgear six-station broaching machine, from which parts are fed by chute to a 19-station Kearney and Trecker transfer machine with magazine loading.

Engines are assembled on a slat-type bench conveyor that runs down the middle of the shop. The layout of the shop is such that delivery of components to the assembly line occurs in a logical sequence. A unique "motoring" section is incorporated in the engine assembly line. This is a system of electric motors and pumps, 20 in all. At a certain point on the assembly conveyor, an electric motor and a pump are automatically attached to the engine. The motor drives the engine at a brisk idling speed, while warm, clean oil from the pump flushes the engine out. Motoring continues for approximately 30 minutes, during which time inspection and minor adjustments are carried out.

Another slat-type bench conveyor, approximately 100 ft long, is used for gearbox assembly. It is served by an overhead monorail circuit, 650 ft in overall length, which delivers sets of components to the assembly station. An ingenious transfer and turn-over station links the gearbox assembly line to the flushing station. Another overhead monorail conveyor system delivers the complete and inspected gearbox away. There is no need to stress the convenience of having to move very bulky and very heavy dies only a short distance.

The area given over to the steel stores and the press shop is 882 ft long and 400 ft wide. In this area the steel stores runs along the whole length of the foot and is 100 ft wide. A wide gangway separates the stores area from the press shop. It is unobstructed by steel supports, and three 25 ton cranes run the full length. Four entrances give direct access into the building for heavy road vehicles. These entrances are tunnel like structures with inner and outer doors. The doors are operated by photo-electric equipment in such a manner that only one door is open at a time. This eliminates heat loss and draughts.

There are 11 bays in the press shop. Only 10 are at present equipped, the other being reserved for future development. There is a basement under nine of the bays. In the basement there are nine conveyors for taking away the off-cuts of sheet metal and delivering them to the baling plant. Steel girders support the under-drive presses mounted over the basement.

In all there are 222 presses in 26 lines. There are also three large and four small multi-spot welding machines. 118 of the presses are of the under-drive type. The remainder are conventional top-drive machines. Here it may be remarked that only three of the presses are foreign built;

A Sigma inspection machine for four- and six-cylinder crankshafts. Operation is completely automatic

it to the engine assembly line. This conveyor system has a circuit length of 3,010 ft.

Rear axles are assembled on a double-strand chain conveyor that runs at bench level. Axle housing, sleeve and flange assemblies are delivered to the assembly line by an overhead monorail conveyor, which also circuits the machining area. Front axle assembly is also carried out on a double-strand conveyor.

Engine, rear axle and front axle assemblies are transported, in sets of three, by an overhead monorail conveyor to the final assembly line in the new car production building. The conveyor has a circuit length of 2,340 ft and is synchronized with the final assembly conveyor. An enclosed service bridge connects the two buildings. It carries in it the unit conveyor and also high pressure hot water and compressed air mains from the boiler house to the two buildings.

The press shop

In plan view, the new factory building is in the shape of a letter L. The foot of the L is a single storey building in which the steel stores and the press shop are housed. An incidental advantage of the new press shop is that it is adjacent to the die shop, which has been considerably extended, whereas the old press shop is some considerable distance they are all nine-station transfer presses.

As is only to be expected, many of the presses incorporate design features that permit the use of loading and unloading devices and other labour-saving and time-saving devices. All the heavy and medium machines are equipped with developments of the "Iron Hand" devices for unloading. Portable band conveyors connect successive presses in the line.

It has also been possible to apply many new loading devices. They are mainly of the compressed air and piston type, synchronized with the stroke of the press and operated by remote control. Shuttle-loaders are also used in connection with multi-spot welding machines and double-acting presses in one bay that is set aside for the production of eight types of door assemblies and two types of luggage boot lid assemblies.

An outstanding feature of this shop is the wide use that is now being made of sheet steel in coil form up to 6 ft wide. For using this material there is a coil feed blanking system comprising a cone type carrier, a set of McKay rolls, a pit 20 ft deep for taking up slack, a timer roll and a single-acting blanking and shearing press. All these units are linked under automatic control. Automatic stacking of blanks is also installed for some operations.

These two lines of British Clearing presses incorporate a considerable degree of automation. They are tooled for door panels and luggage boot lids

A brief description of the scrap baling system is warranted. In the basement under the heavy presses there is a network of eight slat conveyors. Off-cuts travel down chutes on to the subsidiary conveyors, which, in turn, deliver them to the main conveyor. From the main conveyor, the off-cuts fall on to a short-run conveyor leading to the baler. The conveyors are controlled by the baling machine operator. A warning system, broadcast through the basement, indicates when conveyors are to be started up. The operator can also broadcast instructions over this loud-speaker system.

The bales weigh approximately four to five hundredweights. They are compressed to a standard width, but the length and height can vary. The standard width ensures that the bales can be transferred to the loading dock by mechanical means without any danger of jamming in the conveyor. The conveyor from the baler is 126 ft long. It is of the pusher-bar and twin-chain type.

Three overhead monorail conveyors are installed in the press shop to deal with the movement of door panels and luggage boot lid panels. One, carrying outer panels, circulates from the presses to the sound-deadener spray plant and thence to the welding machines. The second circulates from the presses to the welding machines. The third conveyor carries welded assemblies from the press shop to the neighbouring body-building shop. *En route* it decends into a storage basement that has a floor area of 30,000 square feet.

Body-building shop

A total of 353,400 square feet of floor space in the new building may be regarded as given over to body building. Of this area, the actual body-building functions occupy 223,100 square feet, while 106,000 square feet is used for storing pressed panels and 24,300 square feet is used for the production of welded assemblies for use in the body shop.

Six overhead conveyors, with a total length of approximately 5,500 ft, feed the body shop with components and sub-assemblies. Two of these deliver door assemblies from the press shop to the body shop via the basement storage area. Another two feed the necessary parts to the side frame assembly conveyors.

There are also two principal conveyor systems on which the body shells are built. They both operate at floor level, and are of the floor-chain peg type. The first of these conveyors is used for body welding. It is an endless chain, 828 ft long, in the form of a rectangle with sharply radiussed corners. On this conveyor 42 jig trucks of special design travel in continuous procession through the welding stations. Each jig truck comprises a platform approximately 13 ft long and 5 ft wide, mounted on two fixed castors at the front and a special swivel castor at the rear. Although the Victor body dimensions differ from those for the Velox and Cresta cars, the jig trucks are suitable for all.

As was stated earlier, there are two side frame assembly conveyors feeding the main body welding conveyor, one right-hand and one left-hand. Each of these conveyors carries 15 side-frame fixtures. Their movement is synchronized with that of the body welding conveyor. The transfer of a side-frame fixture to the body welding truck is effected by means of a pair of switch rails, although the actual transfer and locking is done manually.

The body finishing conveyor is of the floor-chain and peg type. It has a total run of 2,461 ft. On this conveyor, the bodies are mounted on lightweight trucks for a series of operations to prepare the complete body shell for the phosphate treatment that precedes painting.

From the body finish conveyor, the body shell is transferred to an overhead monorail conveyor for transfer to the body phosphating and rust-proofing system. It has an effective length of 2,183 ft. An interesting feature of this conveyor is a storage bank arrangement. It is not feasible to leave body shells inside the automatic phosphating equipment during the lunch break, and to avoid this the bodies are diverted, at a stated time, into a secondary conveyor. They are automatically fed back into the main conveyor system after exactly one hour.

From the automatic phosphating plant, and on the same conveyor, the body shell is carried through a drying oven, which is in a penthouse above. Here it may be mentioned that this penthouse holds all the drying ovens, furnaces, air replacement and pumping gear associated with painting operations.

After phosphating, the body shell is transferred by means of a special air hoist to the body primer and monotone conveyor system. This conveyor is 3,060 ft long. It carries the body shell through the underbody dip, primer surfacer spray booth, the primer driving ovens in the pent house and back to the paint shop for body painting.

Still on the same conveyor, the body is carried to the wet sanding deck and then up once more to a drying oven in the penthouse. Thence it descends once again to the paint shop and is carried through the colour coat spraying booths. After colour spraying, the conveyor again carries the body up to the penthouse for drying. Finally, the body descends again to the paint shop to be transferred to a polish conveyor running at floor level. This conveyor is 1,032 ft long.

All the conveyors in the paint shop are synchronized. A central control panel enables the controller to set conveyor speeds to give the scheduled output of painted bodies per hour. In addition, the control panel affords instant information of the location and cause of any conveyor stoppage.

A part of the paint shop, separate from that used for body shell painting, is used for painting large sheet metal parts, particularly wings, bonnets and radiator lower grille valances. This painting system also has three synchronized conveyors.

The mode of operation is generally similar to that described for the body shell system.

Body trim shop

This department is located on the first floor of the new building. It occupies an area of 218,700 square feet, while the trim store on the same floor and next to the trim shop has an area of 60,750 square feet. A further 26,325 square feet in the basement is set aside for seat spring-case manufacture, a function that comes under the adminstration of the trim shop.

As with the body-build and paint shops, great use is made of conveyors in this department. The main conveyor of the floor-chain and peg type is 3,060 ft long. It carries 167 body shells on lightweight trucks. Bodies from the paint shop go into an automatic marshalling section, which comprises four conveyors laid side by side, and each 68 ft long. Each of these conveyors holds eight bodies mounted on trucks.

Only two points in connection with the main trim conveyor call for comment. The first is that at one point it is raised from the floor level to a bridge 15 ft high with a 50 ft span. This is to allow unimpeded movement of fork-lift and battery trucks from one side of the trim shop floor to the other. The second is that the conveyor passes through two tunnels equipped with high pressure water jets. The chief object of these is, of course, to ensure that the body is waterproof. At the end of the trim conveyor, the body is lowered by air hoist to the body mounting station on the final assembly line, which is immediately below.

Final assembly

What is referred to in the Vauxhall organization as the "final assembly hall" occupies an area of 163,000 square feet. In this area there are the final assembly conveyors, the final inspection areas, the final finish conveyors and the rectification bays.

There are three feeder conveyors for the final assembly conveyor. The first brings front and rear axles and the power unit complete from a neighbouring building referred to earlier. This overhead monorail feeder conveyor is 2,340 ft long. The body is the next item to be delivered. As already stated, it is lowered by special air hoist from the body trim conveyor on the floor above.

Complete wheel and tyre assemblies, after assembly and painting in the basement, are delivered to the final assembly line by means of special conveyors. The first of these is a twin-chain link and pusher with a lift that is only about 15 deg from the vertical. From this conveyor, automatic transfer is made to a free-running chain link conveyor. The first leg of this conveyor, which runs at ceiling level, is approximately 250 ft long. A second length carries the wheels a further 250 ft to a bridge-like structure that spans the final assembly line. A simple system of air-controlled switches diverts wheels alternately to chutes on either side of the assembly line.

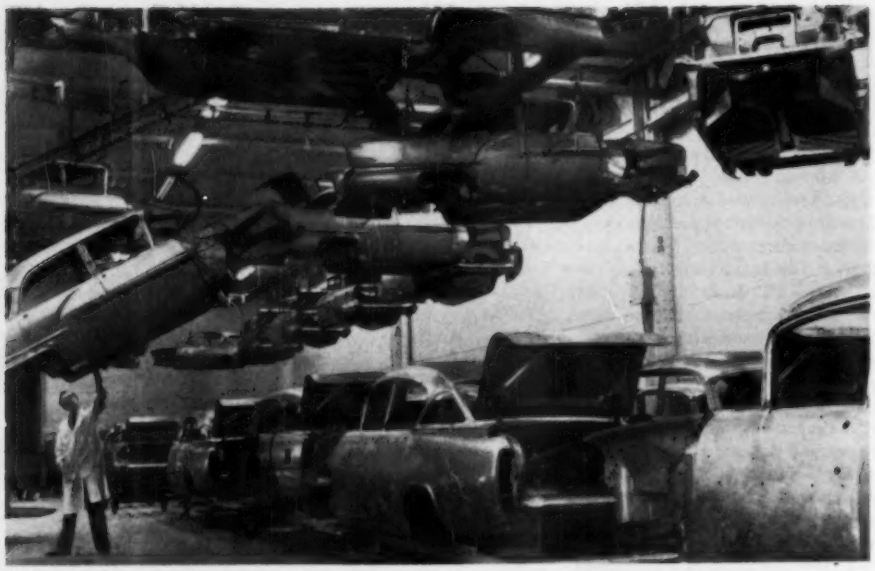
The main assembly conveyor is 960 ft long. It is in two synchronized and linked lengths. The first length is 405 ft long. It is a single-strand slat type conveyor that begins at bench level and gradually rises to shoulder height at the body mounting station. Immediately after wheel assembly, the vehicle is transferred from the single strand to a synchronized two strand slat-type conveyor. This conveyor, which is 570 ft long continues at shoulder level for approximately 250 ft and then dips to run at floor level. Assembly is completed on this final length of conveyor.

At the end of the assembly, the vehicle passes into the hands of the inspector for head-lamp focusing and toe-in adjustment, followed by a roller test that allows the inspector to simulate a road test. After this test the car is driven on to one of three parallel floor-level slat-type conveyors. Each is 222 ft long. For two-thirds of this length, the car is run over well-illuminated pits that permit work to be carried out beneath the car. For the final third of the conveyor length, the car runs through a high intensity light tunnel, where under bright, shadowless light, any imperfections in the paint finish can be readily detected.

The final finish section follows. It comprises two parallel, floor level slat conveyors. On the first length of each conveyor there are spot spray booths for any paint rectification that may be necessary. These are followed by drying ovens and a polishing section. To complete the sequence, there is a final inspection section.

Although it is not strictly germane to a discussion of the methods employed to increase output and productivity, reference must be made to the provisions made to minimize fire hazards in the new car production factory. The manufacturing processes carried out in this building involve the use of large quantities of highly inflammable liquids (cellulose paint, thinners, fuel oils, lubricating oils, petroleum spirit, etc.) and compressed gases (oxygen, acetylene, etc.) and to minimize fire hazards it was decided to house bulk quantities

The main body shell welding conveyor. Side frame sub-assemblies are fabricated in jigs suspended from monorail conveyors running parallel with the conveyor shown in this illustration



This storage conveyor is used to hold body shells during the mid-day break. At the end of the break, the bodies are automatically returned to the main conveyor for transfer to the phosphating plant

of these materials in separate buildings. These separate buildings are:— the paint-mix and paint store building; the boiler house, which serves the main building with high pressure hot water and steam, and special fuel-oil tank storage areas; and finally an oxygen and gas storage building.

Fire prevention methods were also affected by the nature of the manufacturing processes carried out in the main building. A great deal of the work is carried out on assembly lines, and many conveyors pass through interior walls and up and down through floors to maintain a continuous flow of materials from one section to another. The openings that are necessary constitute a fire hazard in that they induce air currents and in an unprotected state would allow fire to spread.

The building shell is partly of reinforced concrete and partly of steel. Bricks, with large areas of asbestos cladding, are used for the exterior walls. Incombustible materials are used for the main roof covering. Cavity-deck asbestos is used on flat sections of the roof, while the remainder of the roof covering is underdrawn with asbestos panelling.

Fire walls, having a minimum of four-hour fire rating, have been erected to separate the various manufacturing areas within the building. Further, in order to restrict lateral travel of heat and smoke, and to ensure early and local actuation of sprinkler heads, specially designed incombustible draught curtains are installed to segregate the manufacturing and storage areas.

Openings in the walls are covered by double metal-clad fire doors, which are automatically self-closing in the event of fire. These doors are suspended on inclined tracks and are counter-weighted to remain in the open position. A fusible element incorporated in the counterweight mechanism is arranged to come into action and cause the fire doors to close automatically when the ambient temperature reaches 155 deg F.

Where there are wall openings for conveyors, the danger of fire spread is countered by means of specially designed tunnels made of incombustible materials. These project on either side of the wall, and are protected by automatic sprinkler heads, which are so mounted as to cause a counter

The trim line conveyor. To allow materials handling trucks to move from one side of the trim shop to the other, the conveyor at one point rises and passes over a bridge 15 ft high with a 50 ft span

Part of the inspection section in the final assembly hall. The high intensity light tunnels can be seen in the background; they allow the slightest imperfection in paint surface to be detected

draught to the convected currents that would be induced under fire conditions. Where conveyors are carried from one floor to another through an opening, fire spread is countered by the erection of wedge-shaped hoods, fitted with automatic sprinklers that direct a finely divided spray of water to oppose the induced convection currents. In the high-risk areas, special ventilators, which operate automatically at an ambient temperature of 155 deg F, are installed for the release of heat and smoke should fire occur. They are installed in side walls and roofs, and their aluminium louvres can be controlled manually as well as by the incorporated fusible elements.

Plating plants and radiator manufacture

Provision has been made for considerable extension of plating and radiator building activities, which are now housed out in a shop that previously housed a great variety of different manufacturing operations. The major plants in the plating section are:—

(1) Two Deinert automatic copper-plating plants
(2) Two Canning automatic nickel-chrome plating plants
(3) A Canning automatic copper-plating plant
(4) Three automatic zinc plating plants
(5) Barrel plating and heat treatment plants
(6) Manual plating plants for copper, nickel and chrome plating operations.

The three Canning and two Deinert plants are by far the most important. One of the Canning automatic nickel-chrome plants was installed some years ago—it was described in *Automobile Engineer*, April 1954—but the others are new. They are all fully automatic. This Vauxhall plating shop is now the largest in Europe.

Polishing is, of course, of fundamental importance to the production of a very high quality of plating. This is another operation that has been mechanized in considerable measure. There are three in-line continuous polishing machines, seven horizontal return automatic polishing machines and eight rotary table polishing machines.

One further item must be given brief mention—the Vauxhall proving ground, which is approaching completion. This will allow tests of a character that hitherto could be carried out only at the Lindley proving ground of the Motor Industry Research Association. In terms of money, this development is only a minor item in the expansion programme, but it must be of great value for the future.

BOOKS of interest to AUTOMOBILE ENGINEERS

DIESEL MAINTENANCE

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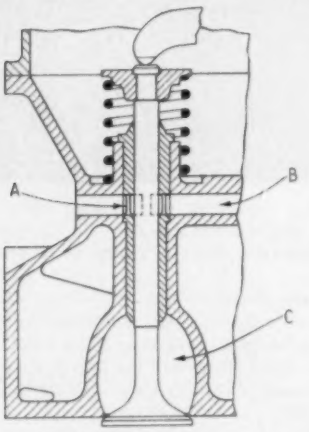
CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Overhead valve guides

Even with accurate fitting of the valves in their guides, lubricating oil is liable to be drawn into the combustion space when the throttle opening is restricted and the depression in the cylinder or in the valve passage is enhanced. Such adventitious oil can impair output and disturb the running of the engine. The invention proposes a ported valve guide that provides a means of escape for the oil before it reaches the valve passage.



No. 774619

In the example, the valve guide is furnished with a series of ports A, spaced around the circumference, which put the bore of the guide in communication with a pressure-equalizing passage B. This passage, which may be arranged either longitudinally or transversely in the cylinder head, is open to atmosphere, but not necessarily direct to the outside air. It will have no connection with the valve gear housing above.

Vacuum occurring in the valve passage C can thus be propagated only as far as the passage B, so that in practice a suction effect is no longer exerted in the valve gear housing. Any oil penetrating by way of the valve guide bore can be drained away through passage B. Where valves are arranged in line in a multi-cylinder head a common passage B may be provided. *Patent No.* 774619. *Daimler-Benz A.G.* (*Germany*).

Divided propeller shaft

With the object of keeping relatively low the overall height, the centre of gravity, and the floor level of the passenger compartment, while avoiding excessive height of the shaft tunnel in the compartment, the propeller shaft of this vehicle is divided. The forward shaft A is connected to the extended output shaft of the gearbox by a universal joint and is substantially aligned with the gear shaft to eliminate angularity of drive through that joint. Shaft A inclines down to the rear, over frame cross member B, and at its rear end is supported from the underside of frame cross member C in a resiliently mounted ball bearing D.

The rear propeller shaft E is connected to shaft A by a universal joint and to the pinion shaft of the differential gear F by a further universal joint. Although the drive gears to the differential are of the hypoid type, the pinion shaft is inclined forwardly down so that the shaft E is approximately horizontal. Both universal joints are disposed beneath the rear seat.

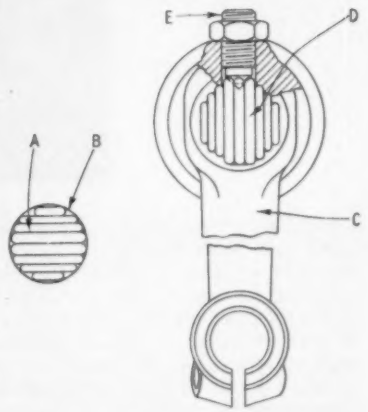
Drive angularity between shaft A and the pinion shaft is divided between the two universal joints and increased angularity at one joint, occasioned by vertical deflection of the axle, is offset by reduced angularity at the other joint. *Patent No.* 773,667. *General Motors Corp.* (*U.S.A.*).

Laminated torsion bar

In a torsion bar consisting of a stack of spring leaves all of equal width, the outer leaves are subjected to bending stresses in addition to twisting. Any fractures that may occur, therefore, are initiated exclusively at the point of support of the outer leaves. The bar forming the subject of this invention is built up of leaves of decreasing width from the centre outwards, so that the assembly can be received in a circular, or substantially circular bush. Since it is desirable that the maximum loading of individual leaves should be approximately equal, the leaves may be of varied thickness, generally decreasing from the centre outwards.

It becomes possible to so dimension the outermost leaves that they are loaded to a somewhat lower value than intervening leaves. Any fracture would then occur in an intermediate leaf and would be less incapacitating in its effect as the broken leaf would be supported and twisted by the adjacent leaves on each side. The better disposition of the overall section of the bar enables the anchoring sockets and the actuating levers to be smaller and lighter than those required for a conventional rectangular assembly of leaves.

The illustration shows a bar made up of eight leaves A of differing widths and thicknesses and presenting a total cross section that almost completely occupies a circumscribing circle B. A lever C has a hub with a bore suitably profiled to receive a nine-leaved bar D so that pressures are distributed over several or all the leaves instead of being concentrated, as in conventional designs, on the two outer leaves. In this assembly the three central leaves are of identical dimensions but the three leaves on each side are successively decreased in width and thickness. The bar is retained in the lever against axial displacement by a set-screw E. *Patent No.* 775249. *Volkswagenwerk G.m.b.H.* (*Germany*).



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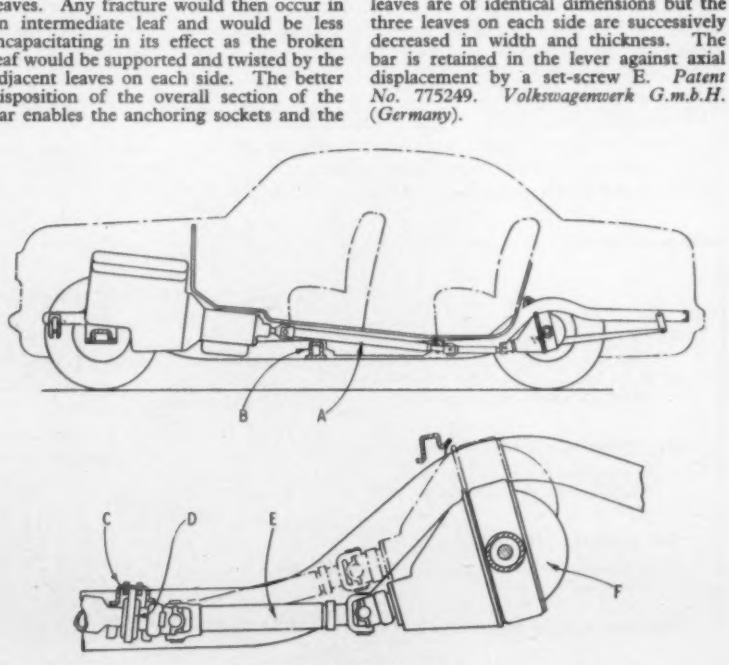

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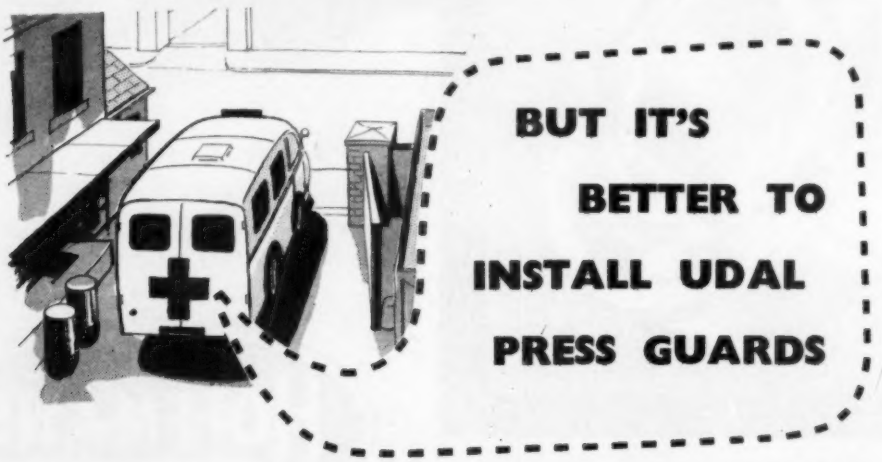

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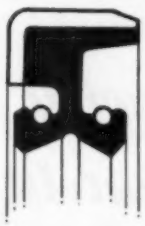
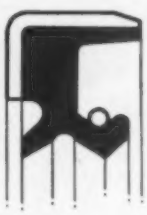


TYPE 12 P

A rotary shaft seal used to separate two different fluids.



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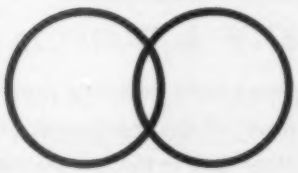

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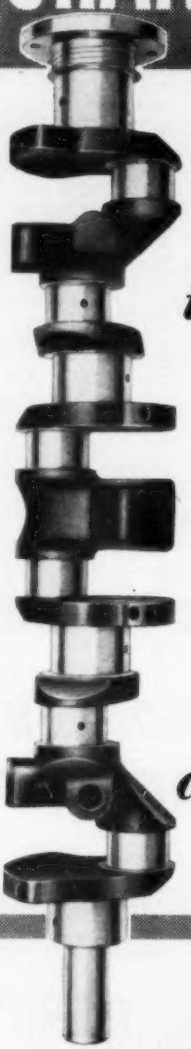

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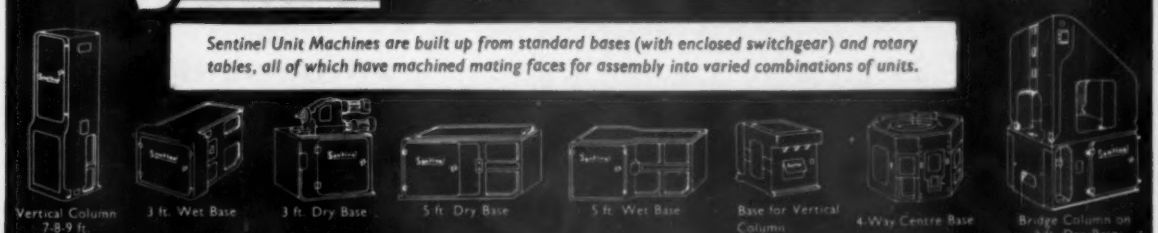
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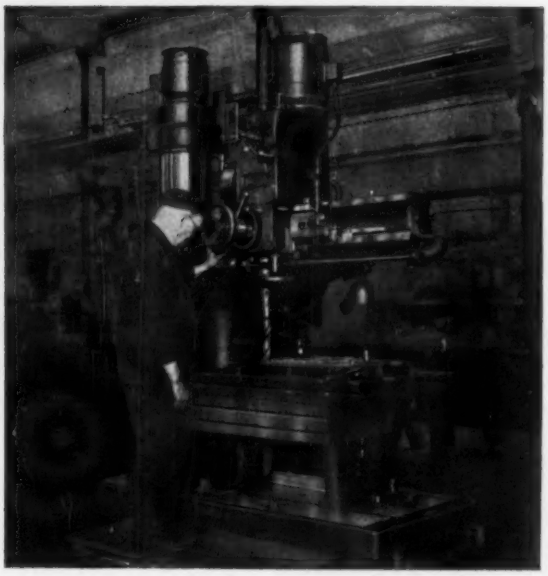

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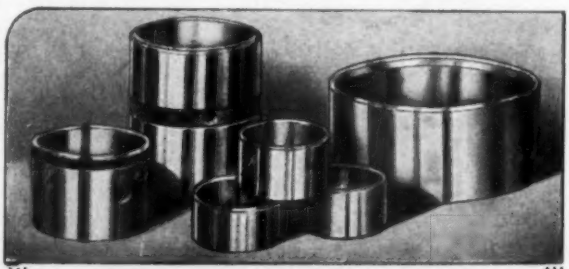

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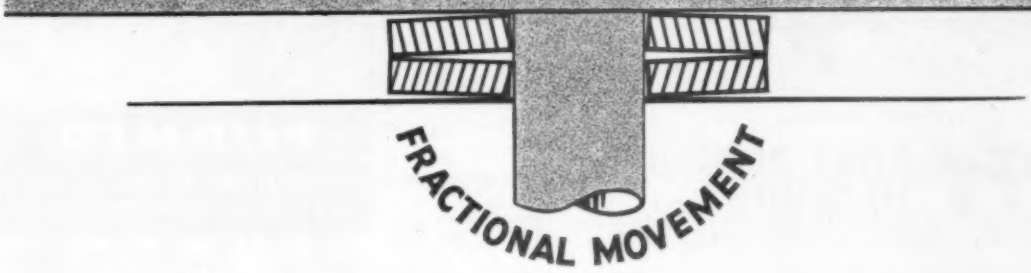

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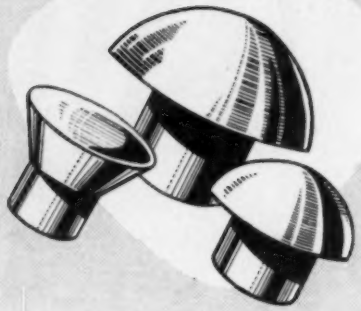

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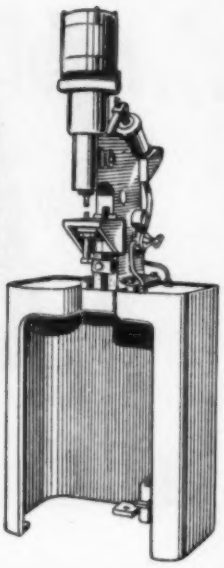

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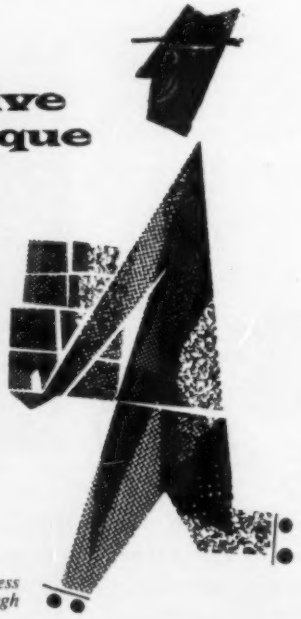

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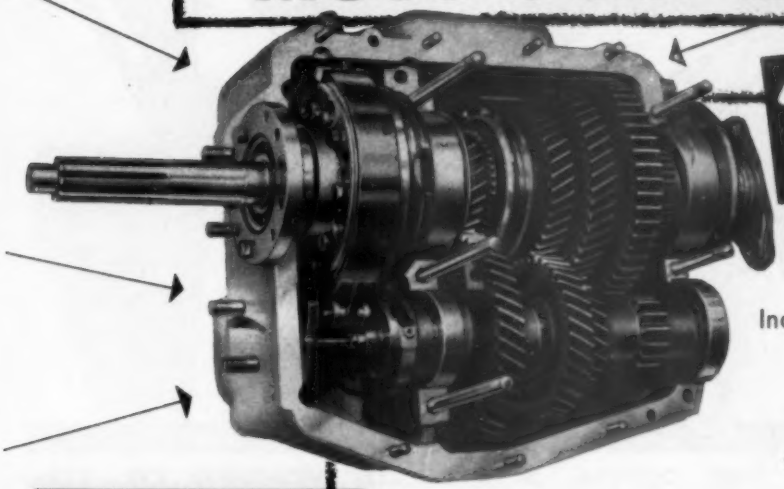

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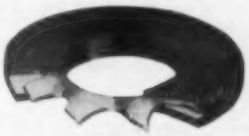

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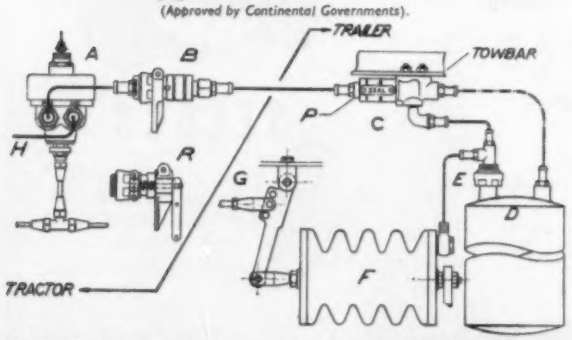

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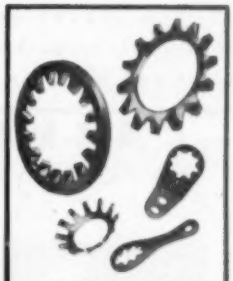

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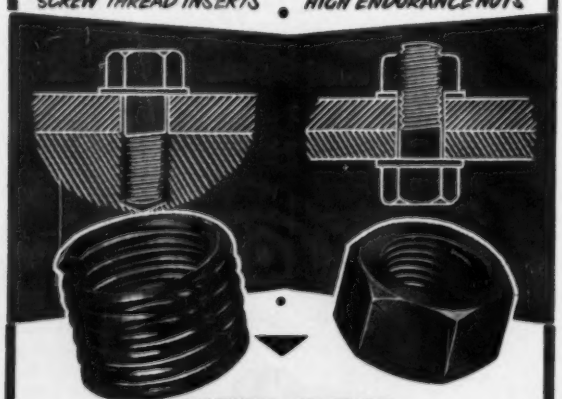

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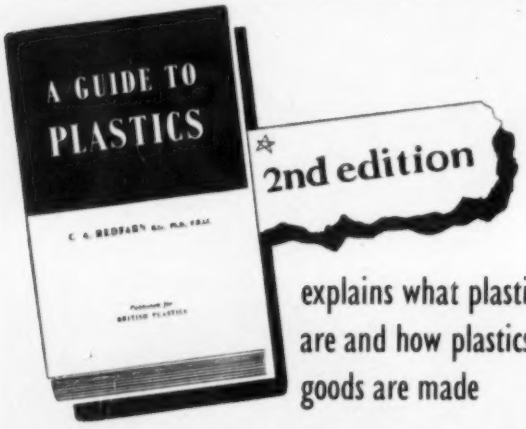

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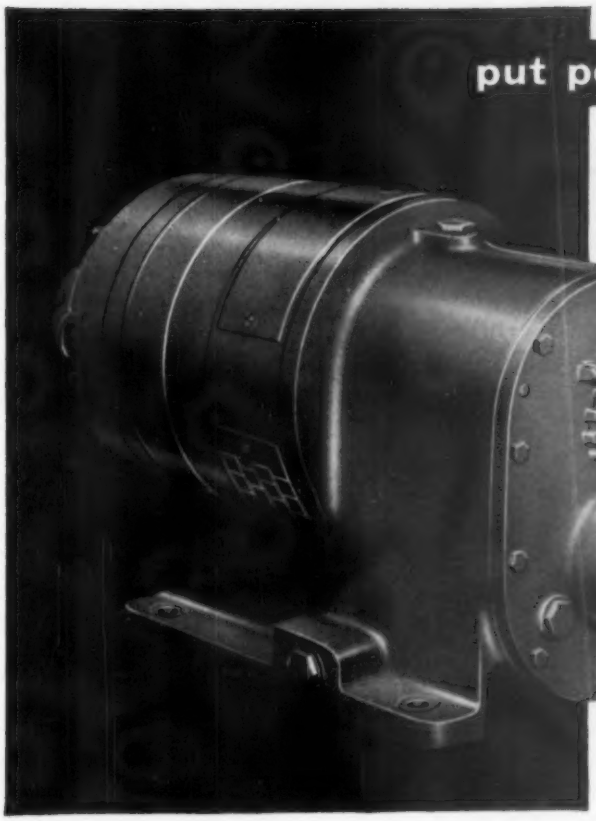

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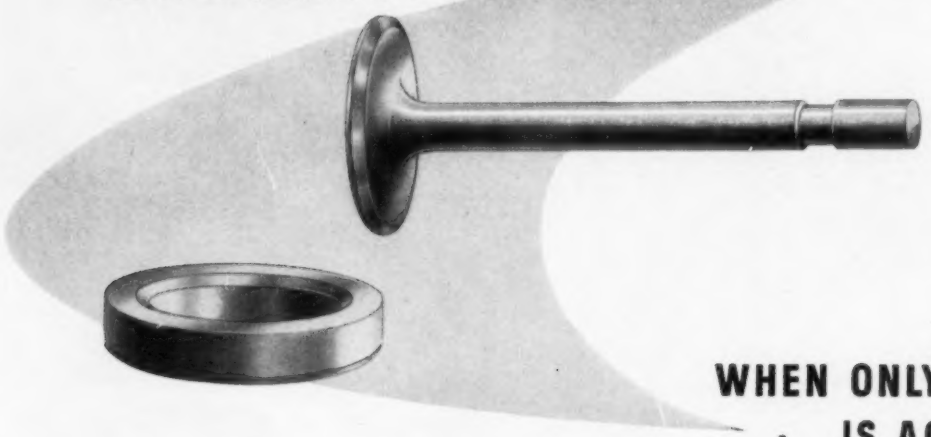

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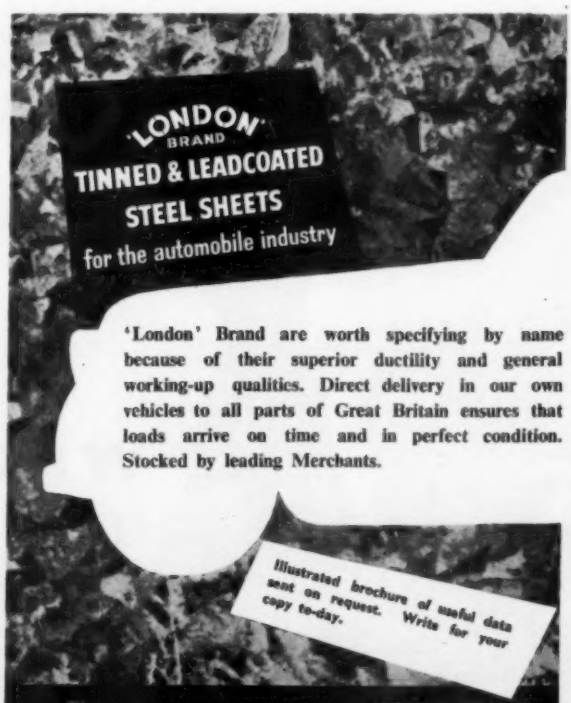
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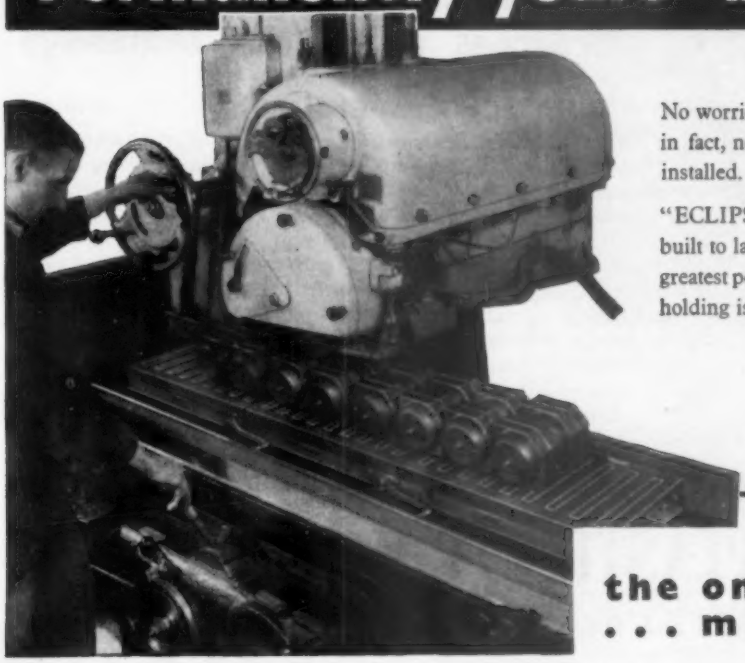

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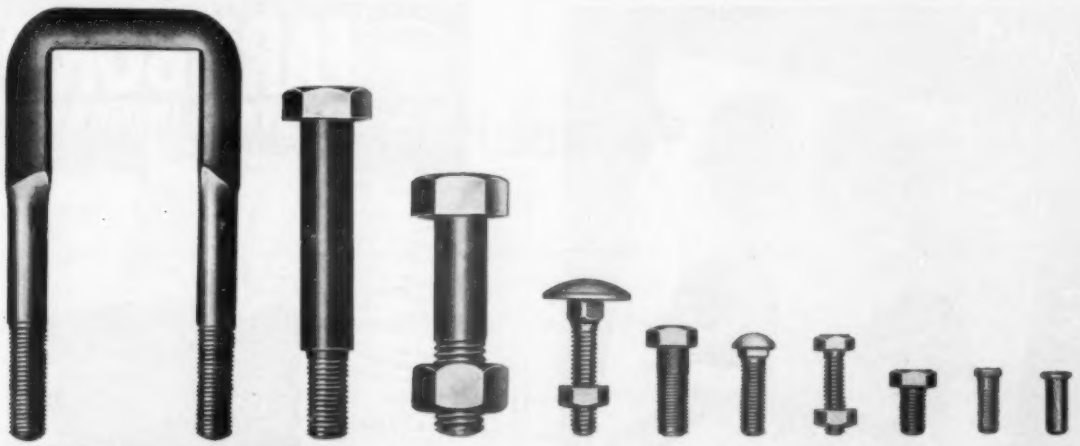

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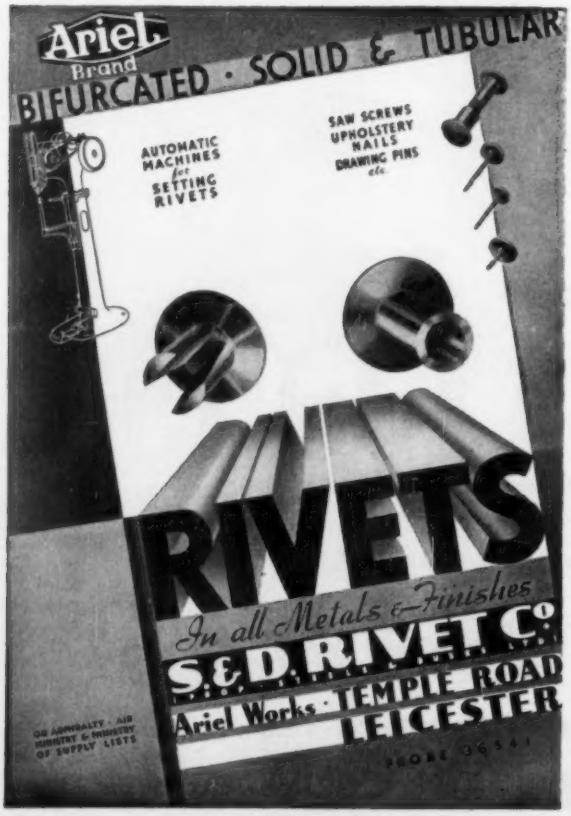

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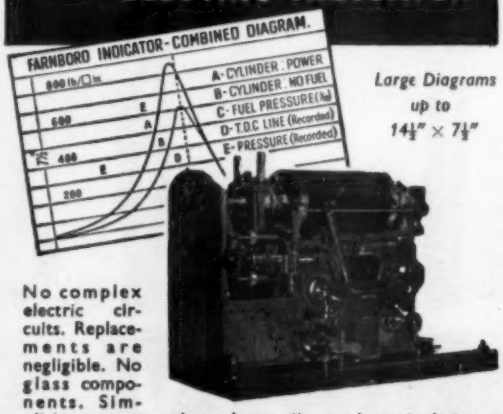

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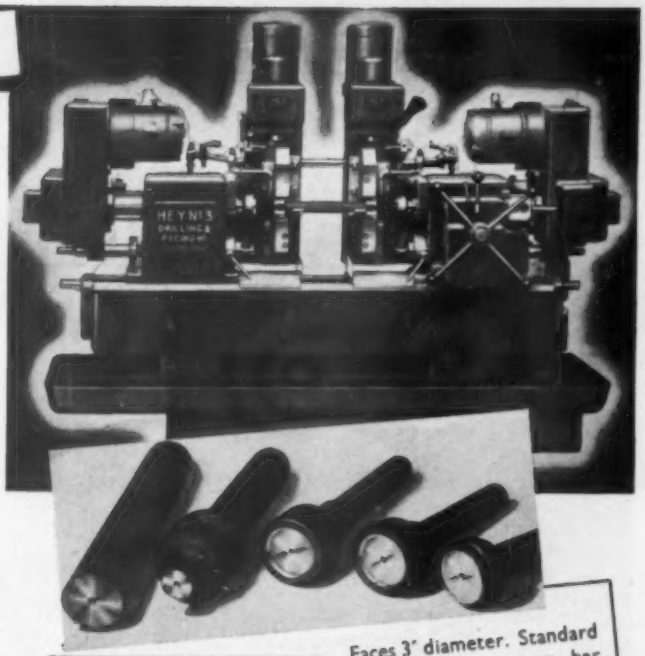

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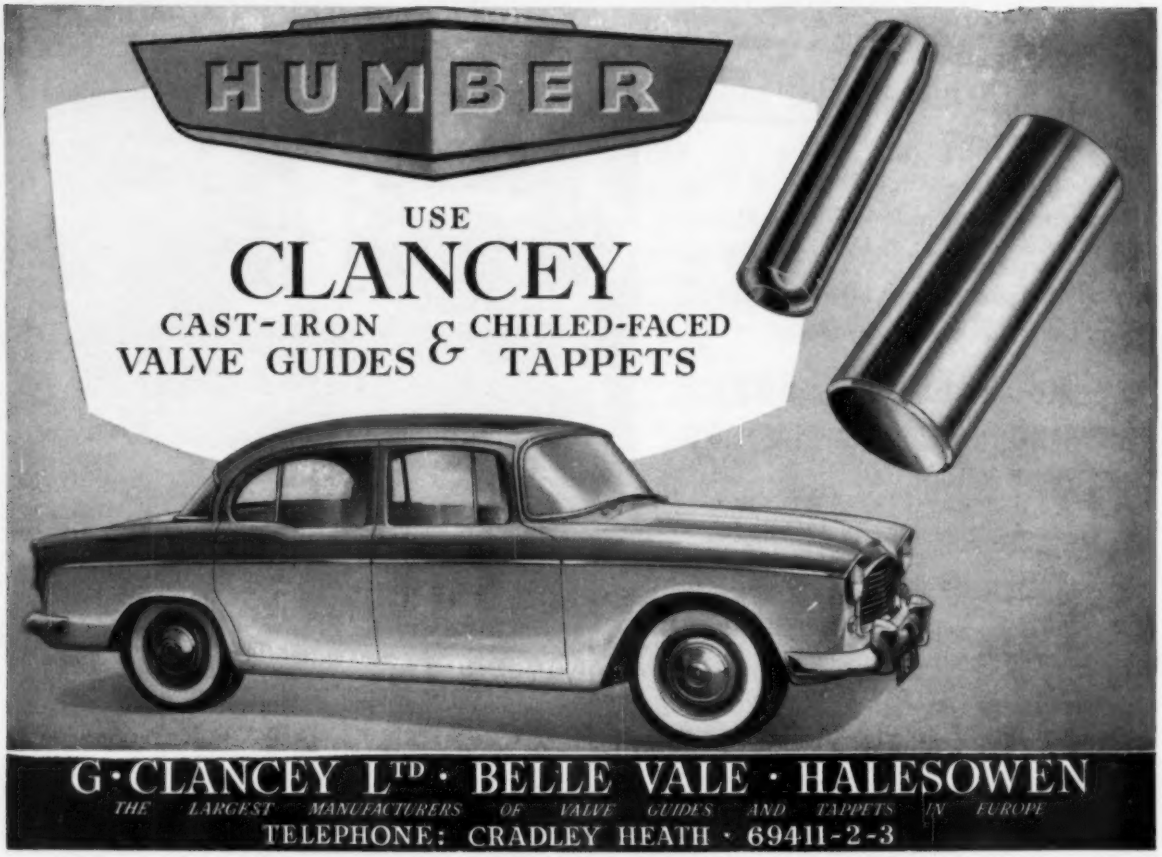
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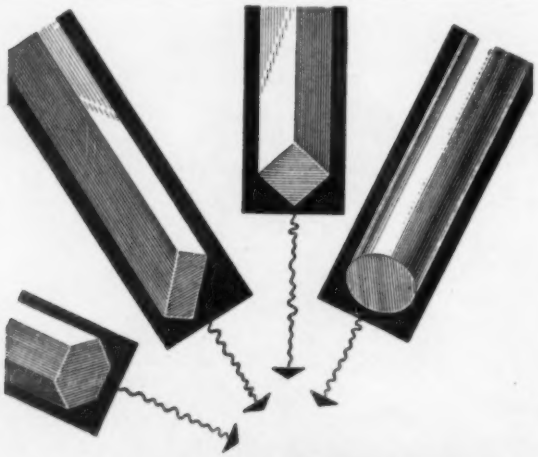

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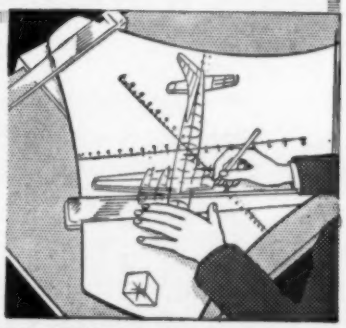

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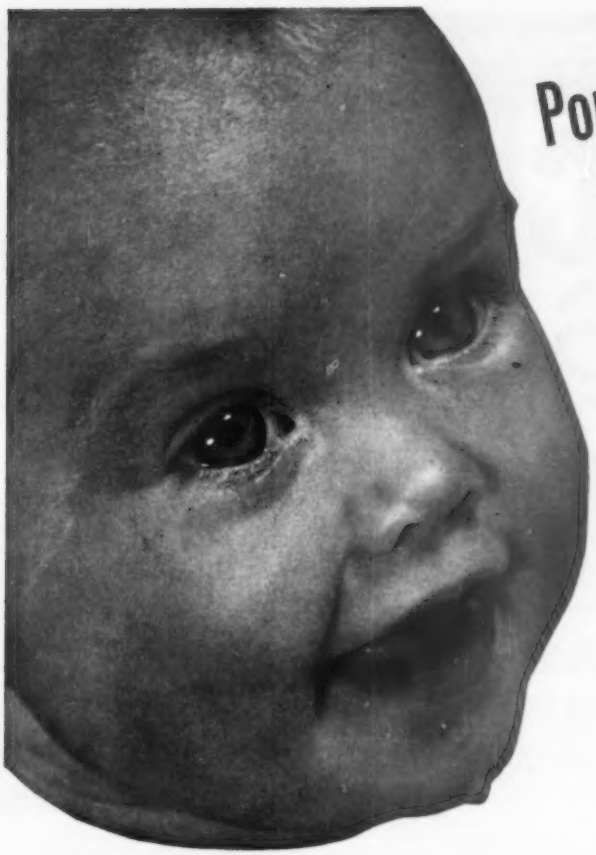

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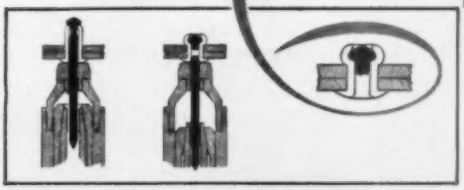

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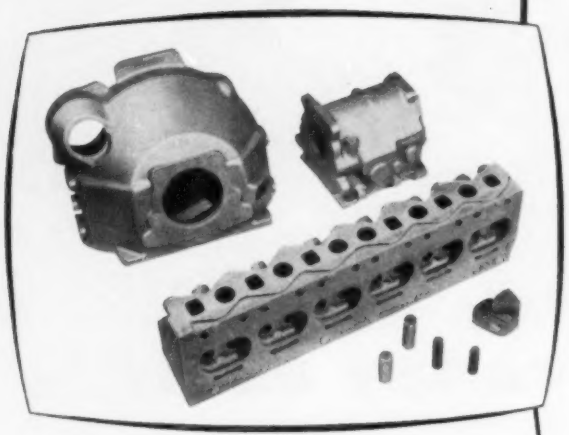

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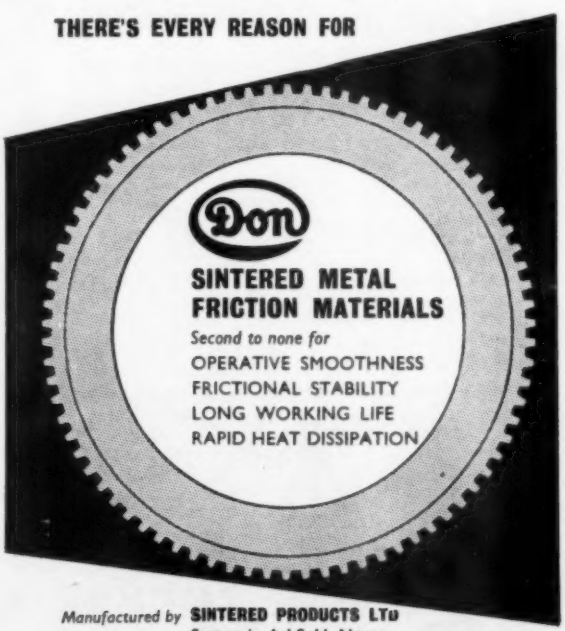

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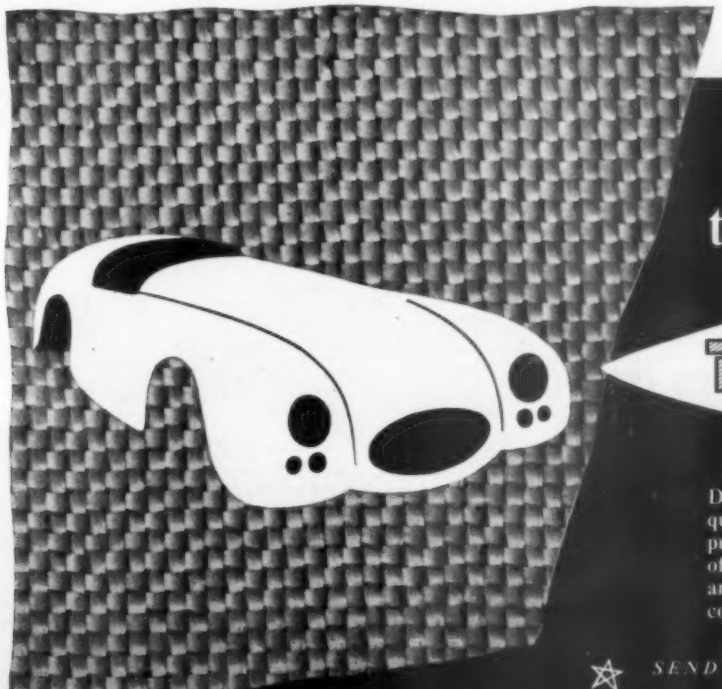

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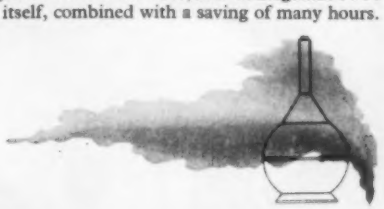

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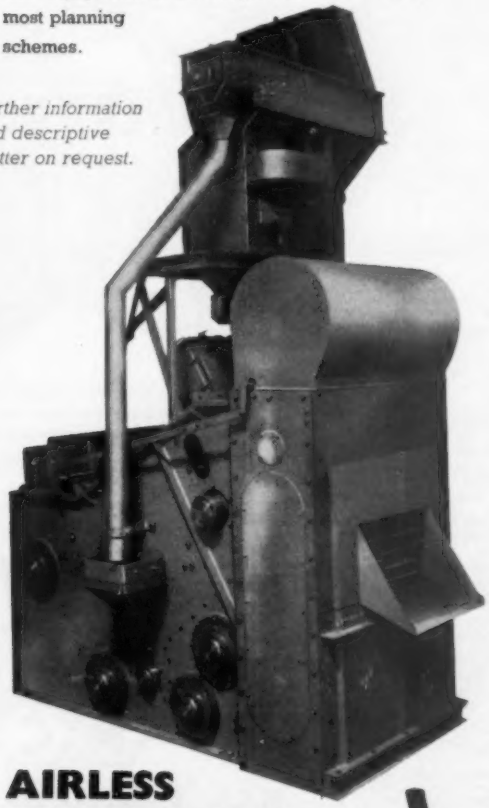

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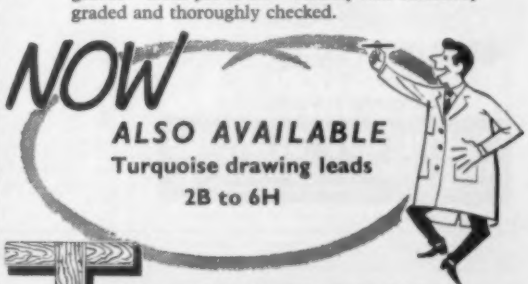

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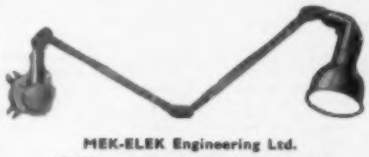

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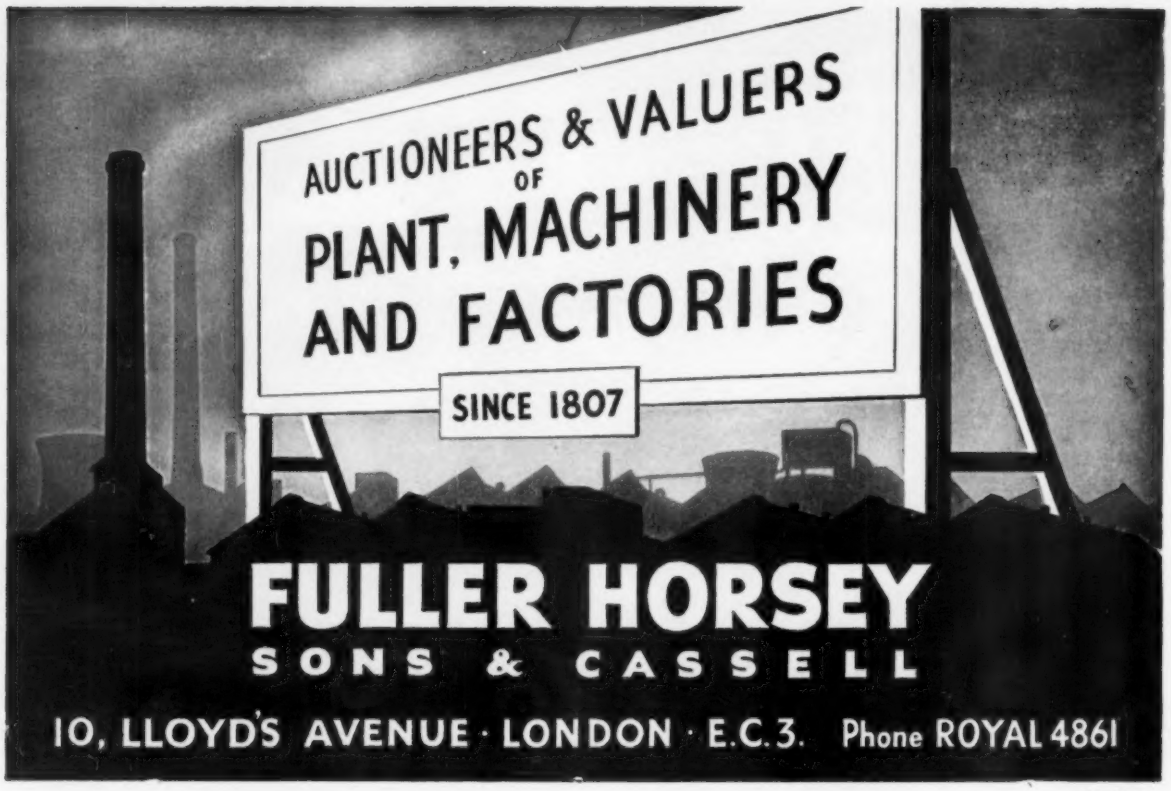

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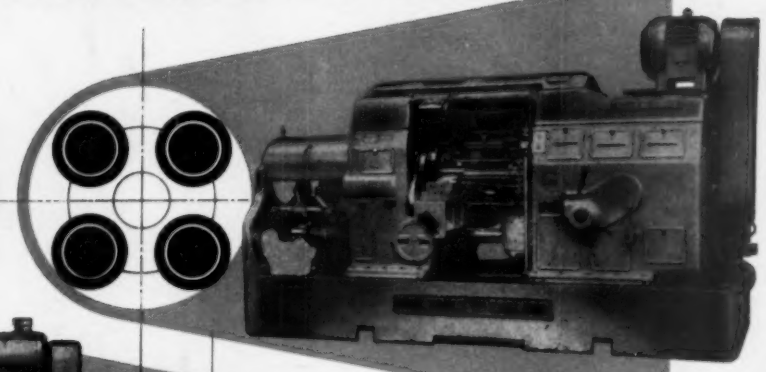

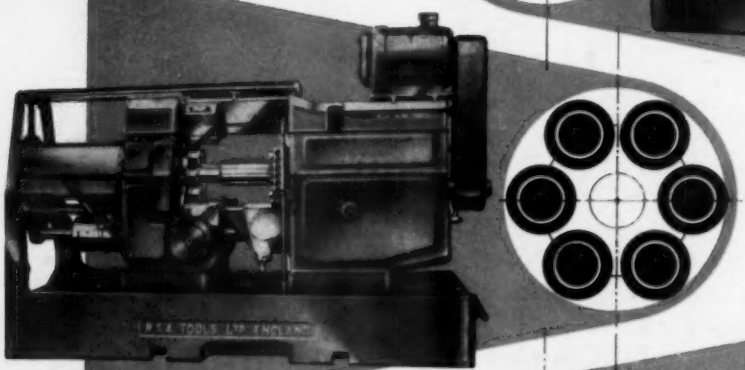

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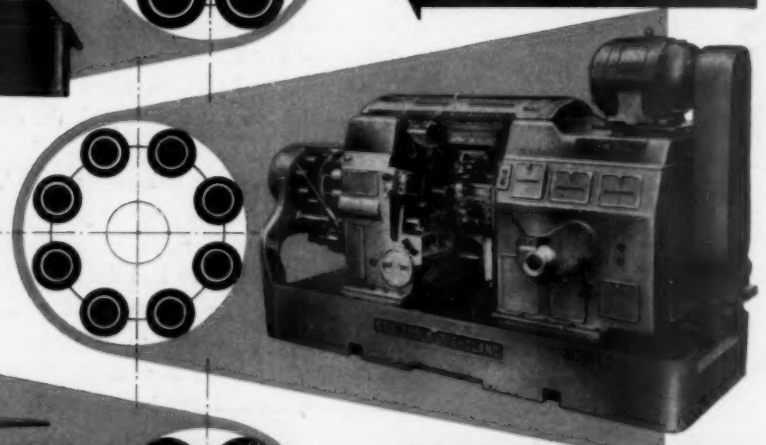

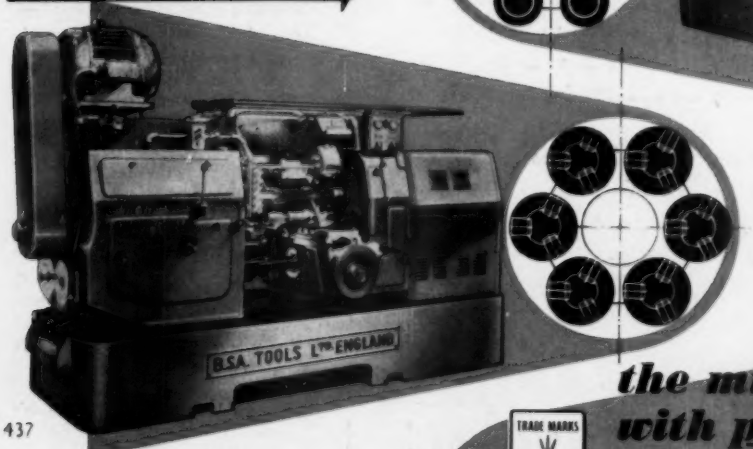

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